US009398779B2

(12) **United States Patent**
Turner

(10) **Patent No.: US 9,398,779 B2**
(45) **Date of Patent: Jul. 26, 2016**

(54) **ARTICLES OF APPAREL INCORPORATING CUSHIONING ELEMENTS AND METHODS OF MANUFACTURING THE ARTICLES OF APPAREL**

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(73) Assignee: **NIKE, Inc.**, Beaverton, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 408 days.

(21) Appl. No.: **14/029,945**

(22) Filed: **Sep. 18, 2013**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**

A41D 13/015	(2006.01)
A41D 13/05	(2006.01)
A41D 31/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A41D 13/015*** (2013.01); ***A41D 13/0156*** (2013.01); ***A41D 13/05*** (2013.01); ***A41D 13/0543*** (2013.01); ***A41D 13/0562*** (2013.01); ***A41D 13/0593*** (2013.01); ***A41D 31/005*** (2013.01)

(58) **Field of Classification Search**

CPC A41D 13/015; A41D 13/0562; A41D 13/0593; A41D 31/005; Y10T 156/1052

See application file for complete search history.

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(57) **ABSTRACT**

A method of making articles of apparel that include a base layer having a first surface and an opposite second surface. The base layer is associated with a thermoplastic polymer element, then an aperture is formed through the base layer and the thermoplastic polymer element. A cushioning elements that may have a first material layer, a second material layer, and a plurality of foam components is positioned proximate the aperture. The first material layer and the second material layer are bonded to the second surface of the base layer. The foam components are located between and secured to the first material layer and the second material layer. In addition, the foam components are positioned to correspond with a location of the aperture.

19 Claims, 59 Drawing Sheets

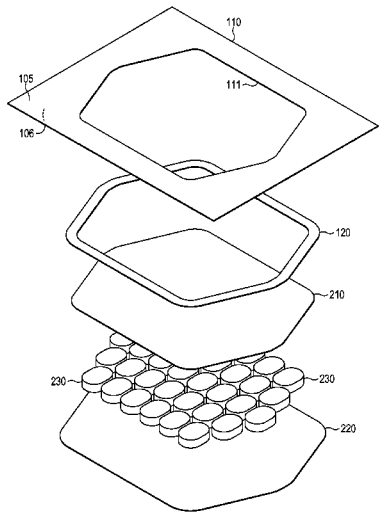

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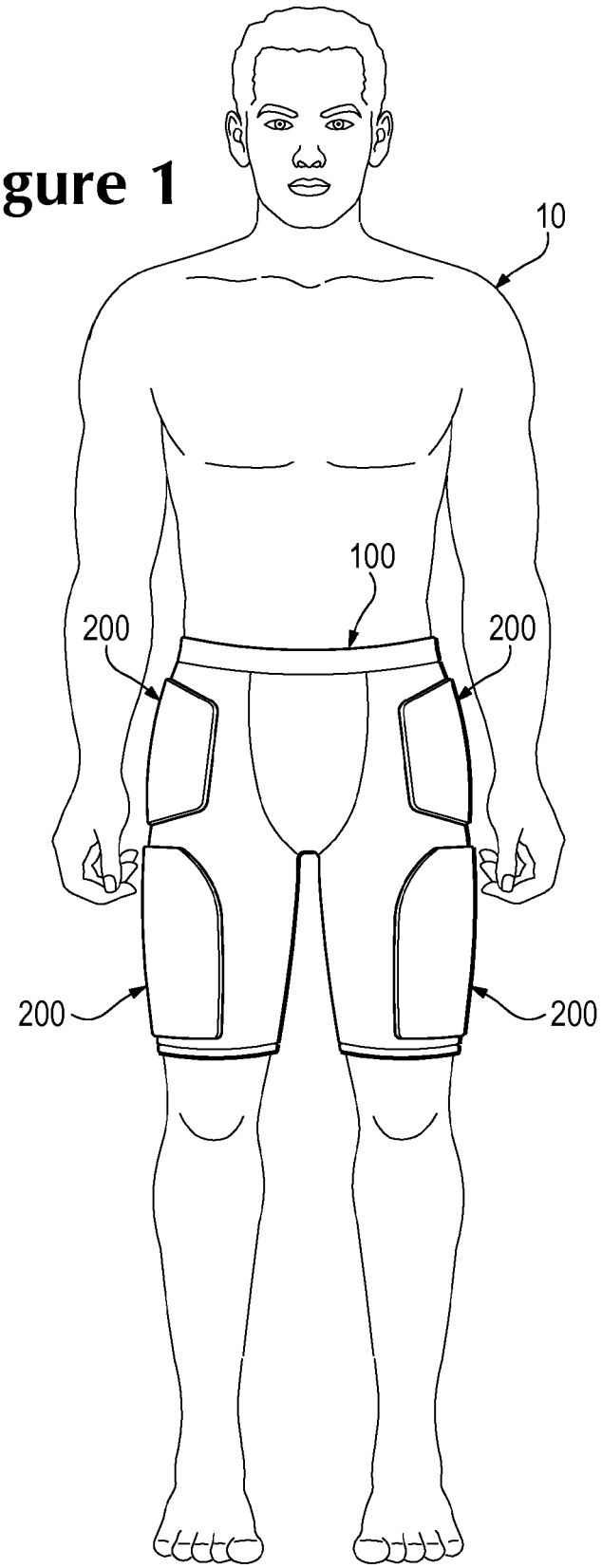
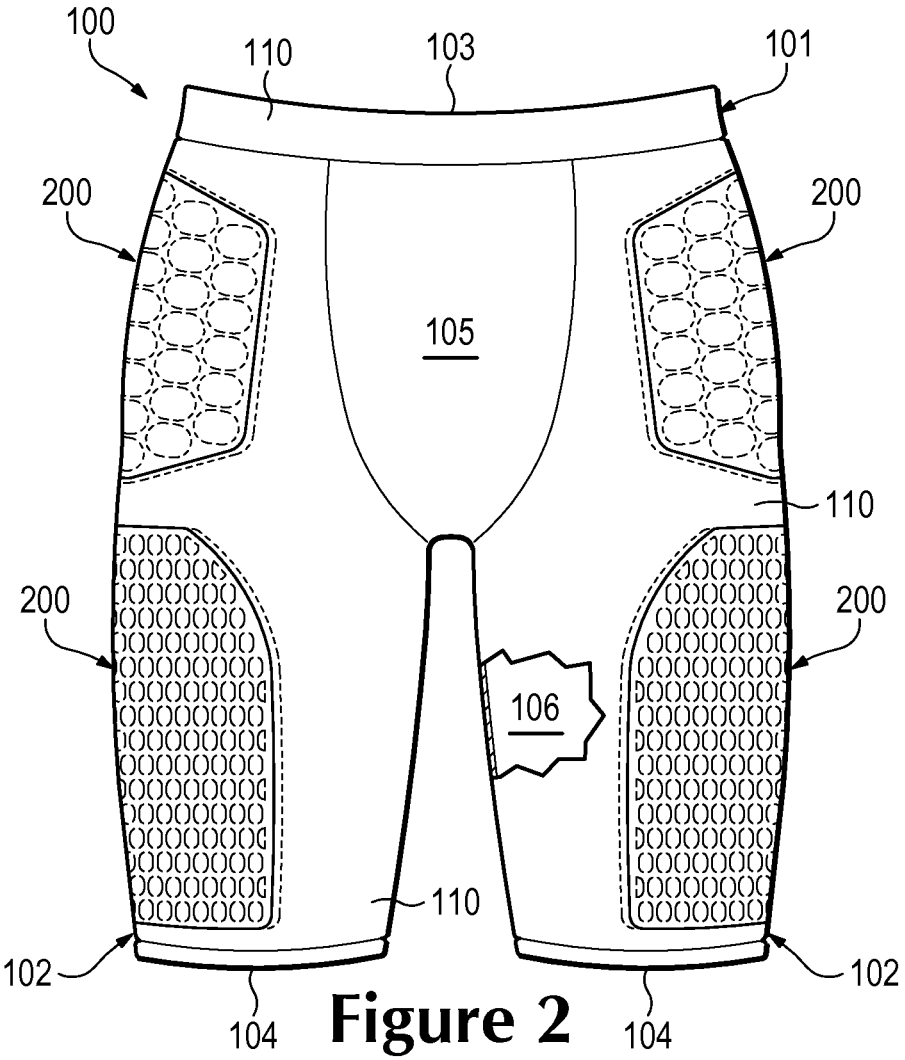
Figure 1





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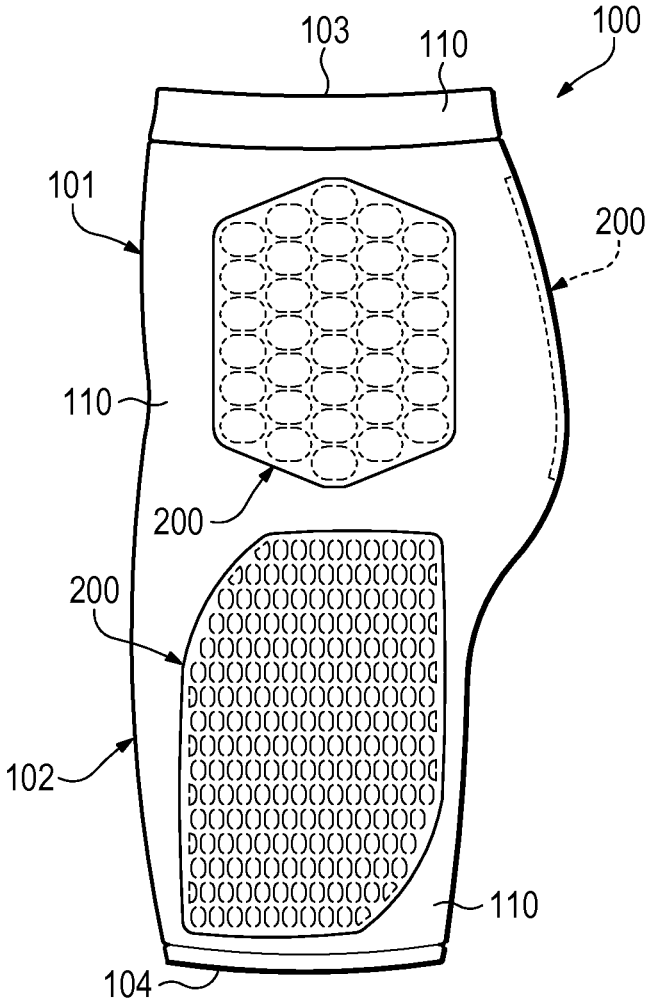

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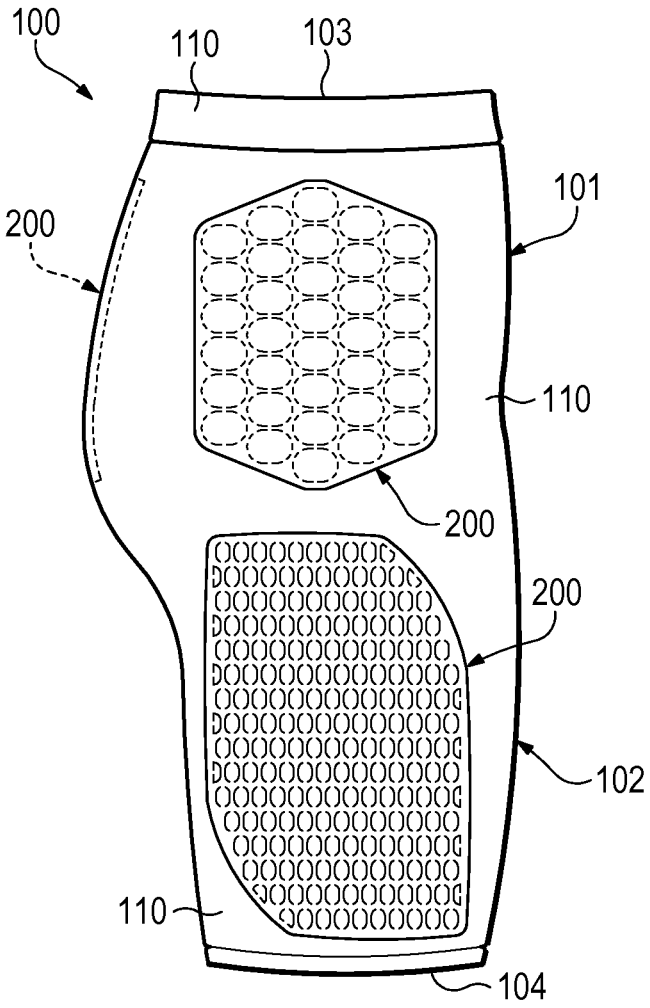

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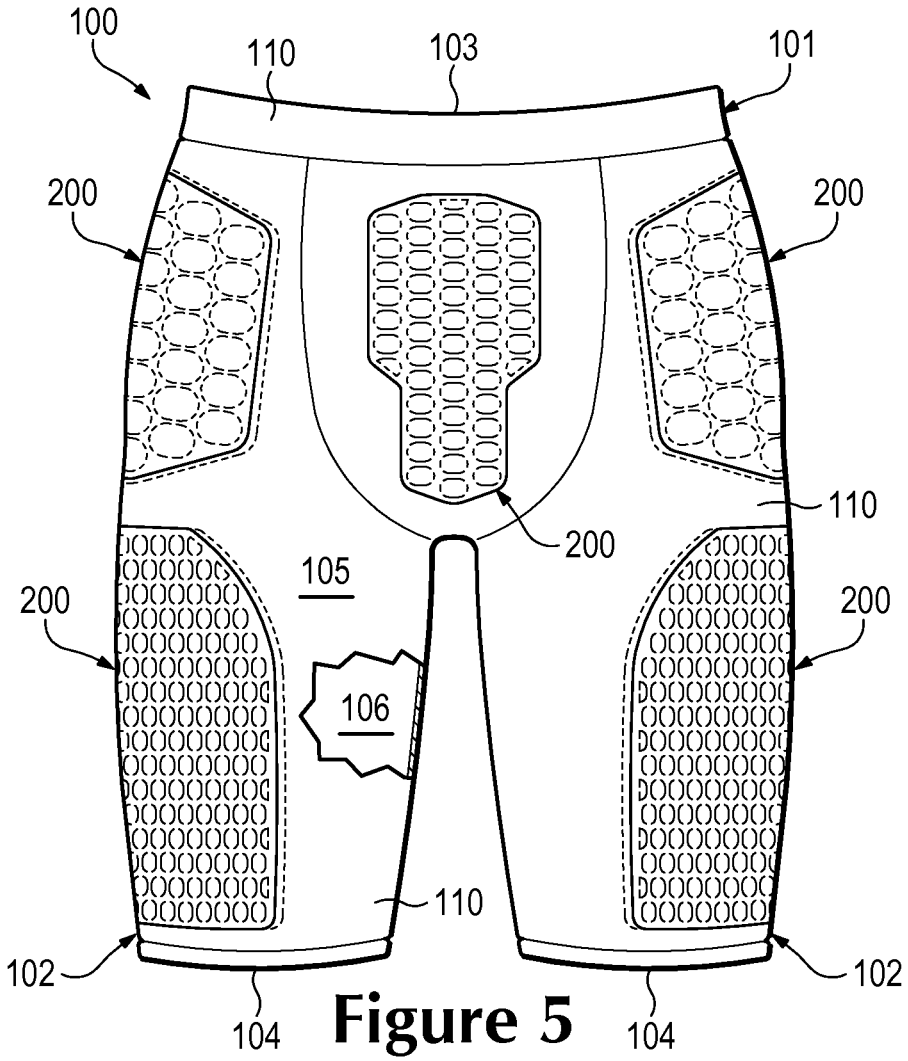
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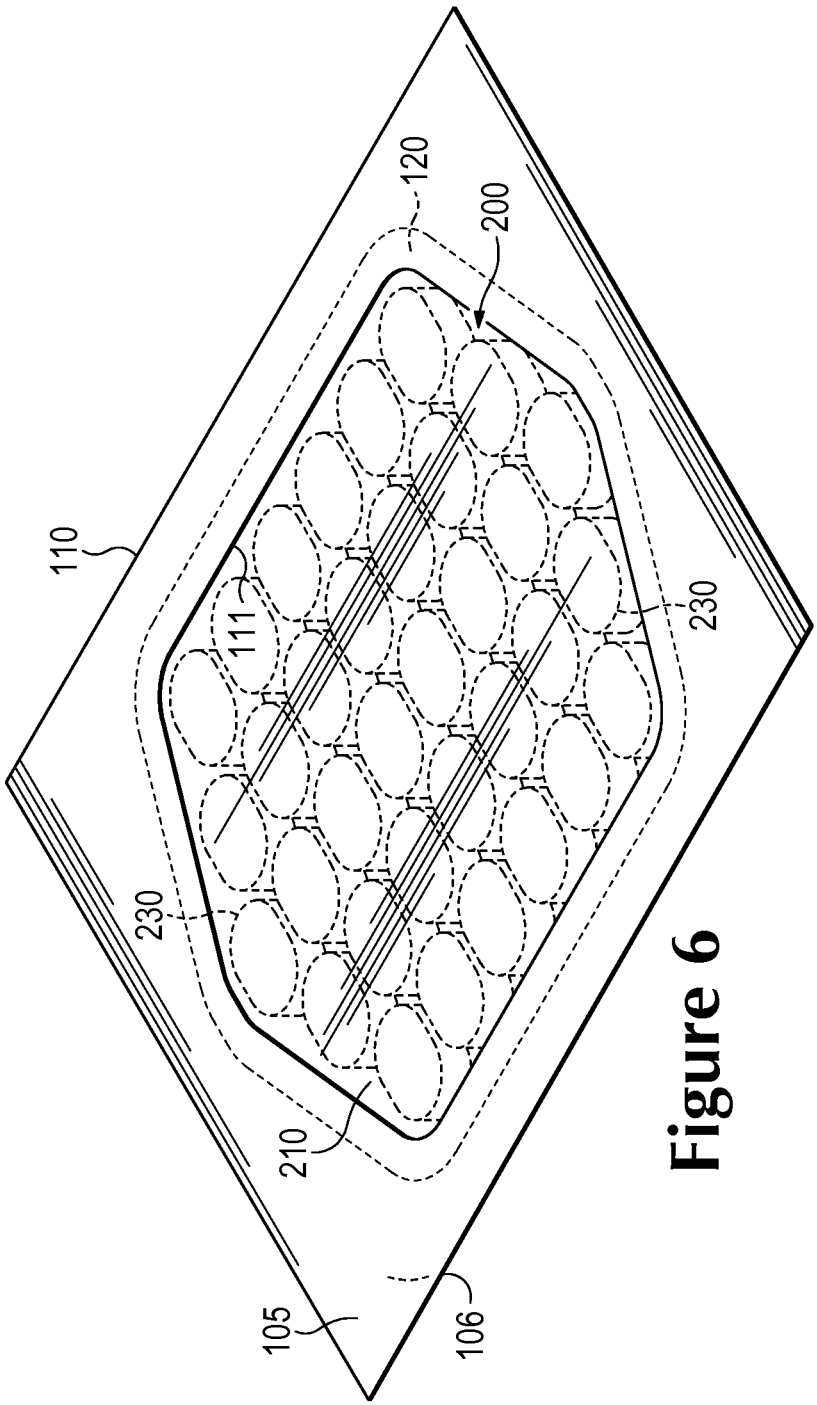

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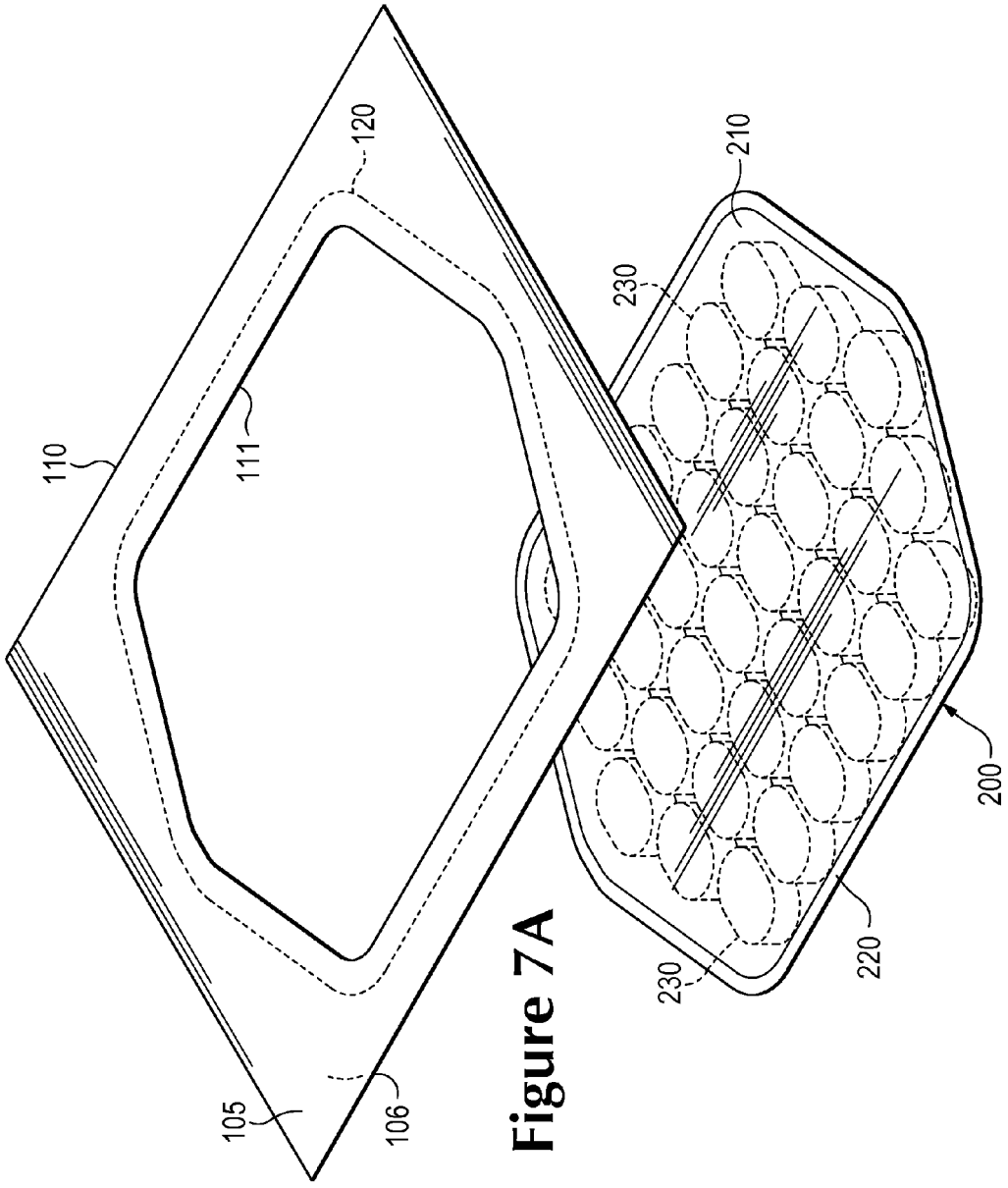

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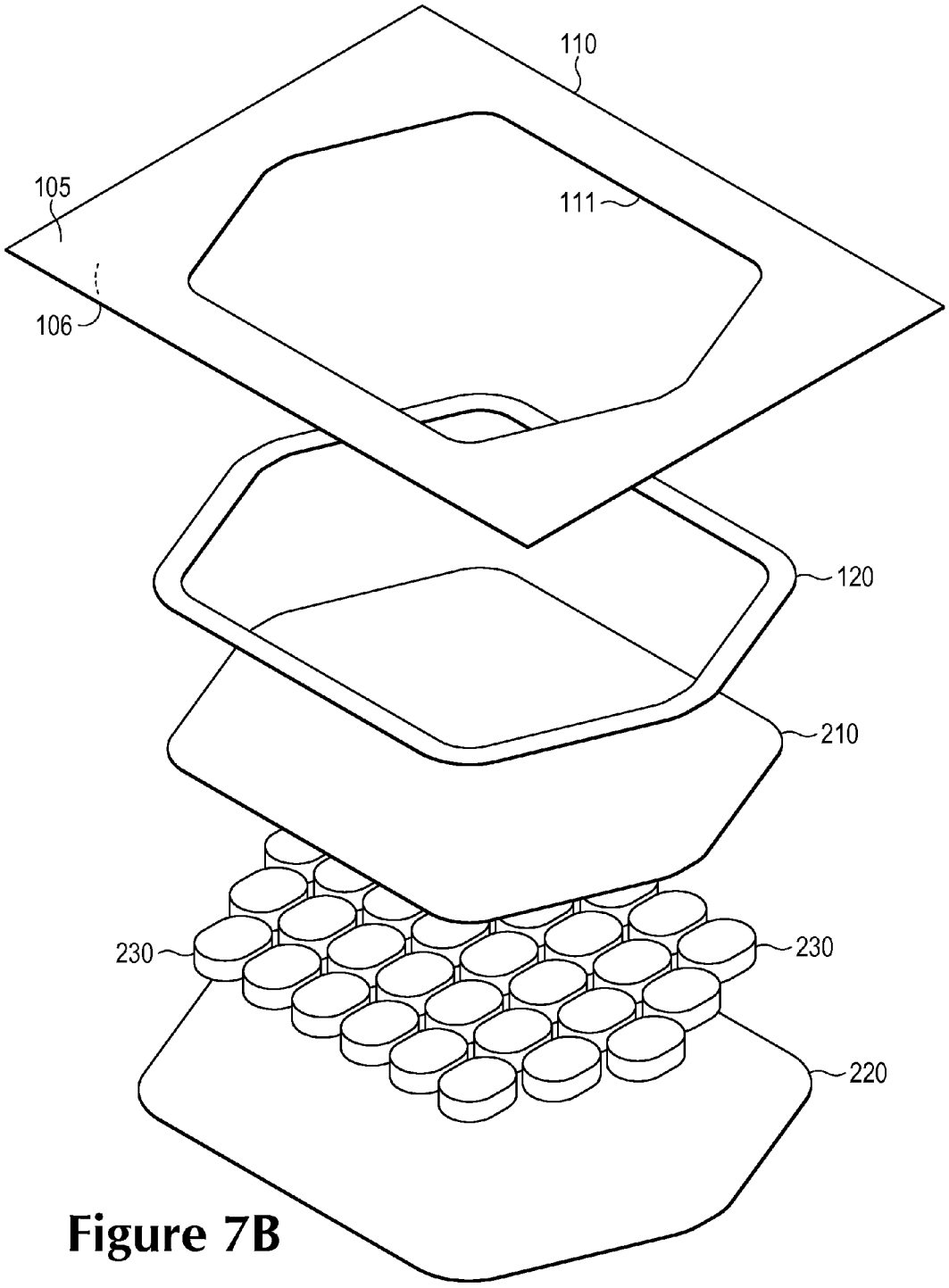

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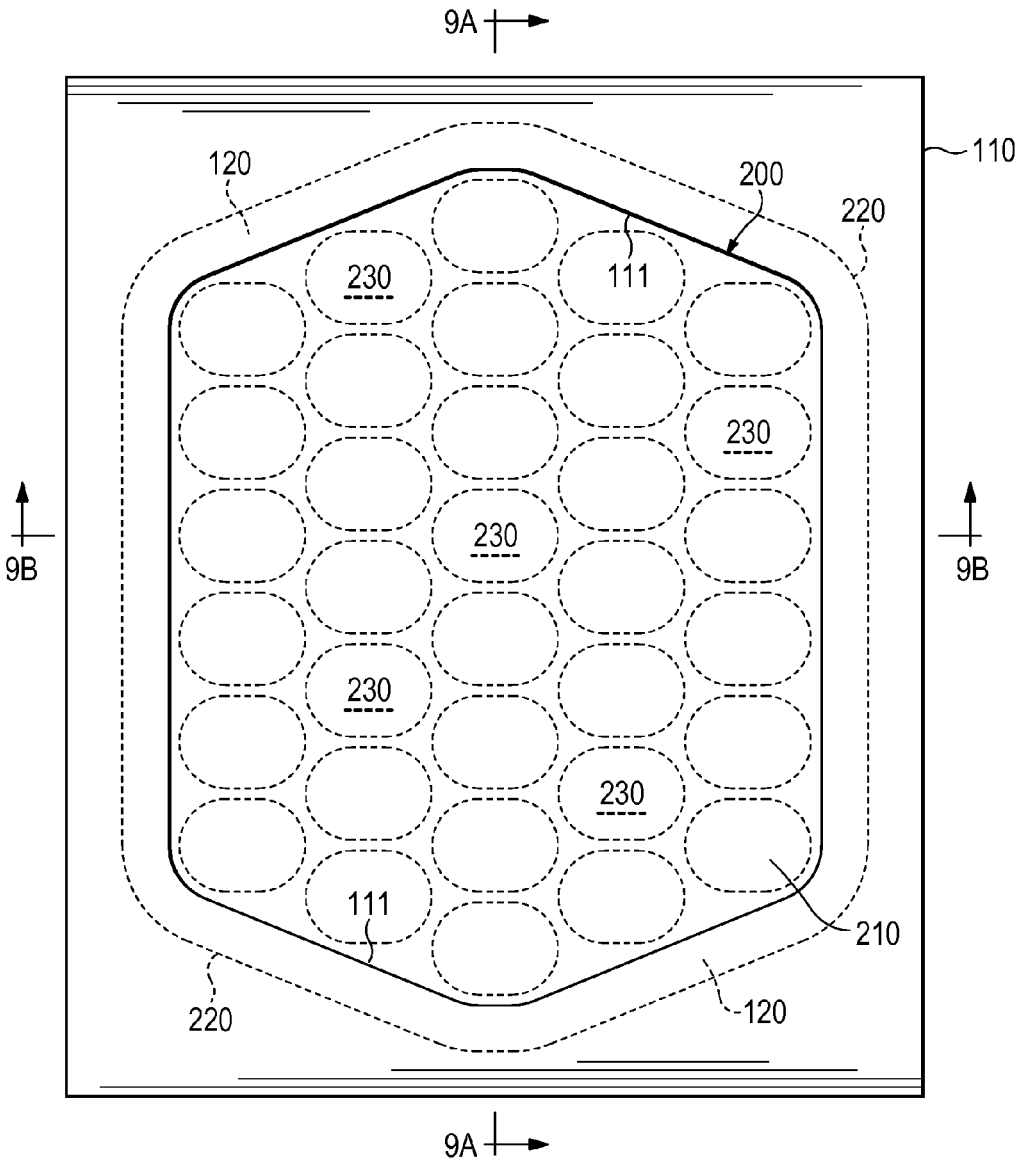
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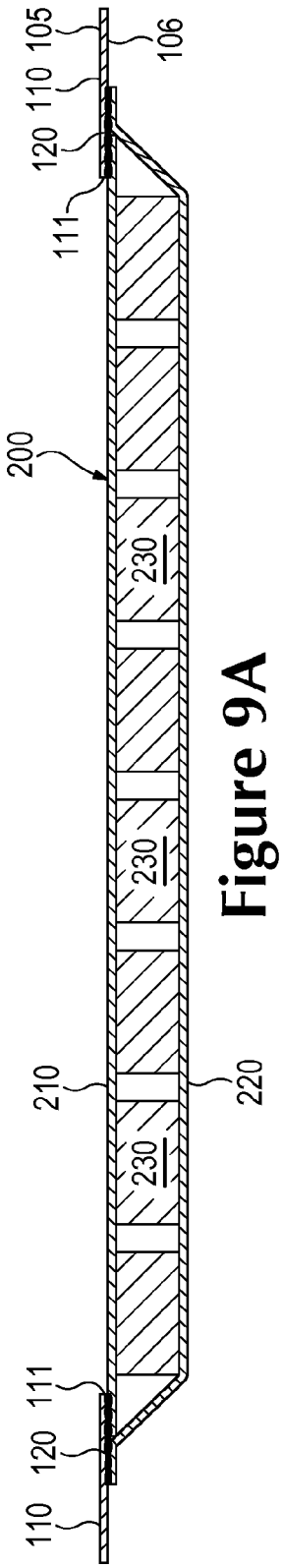

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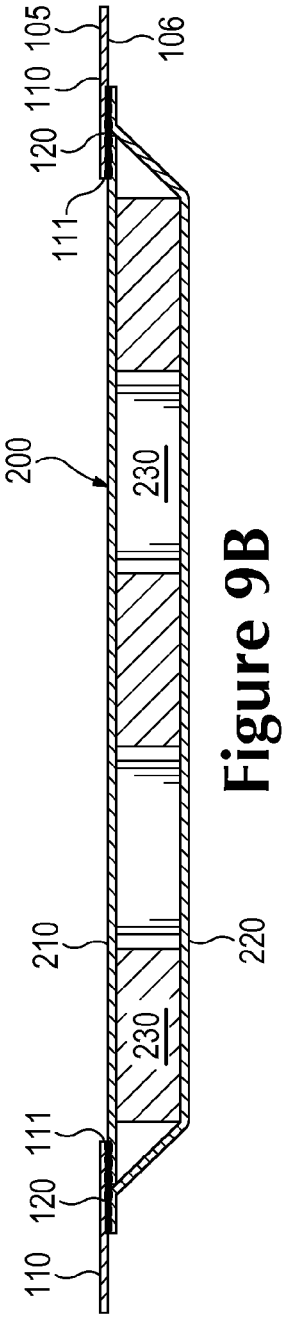

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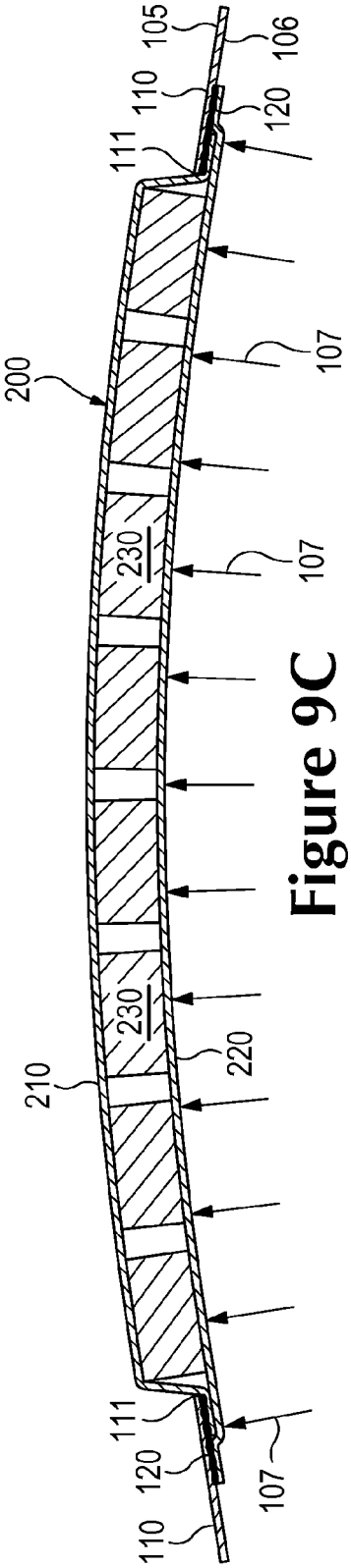

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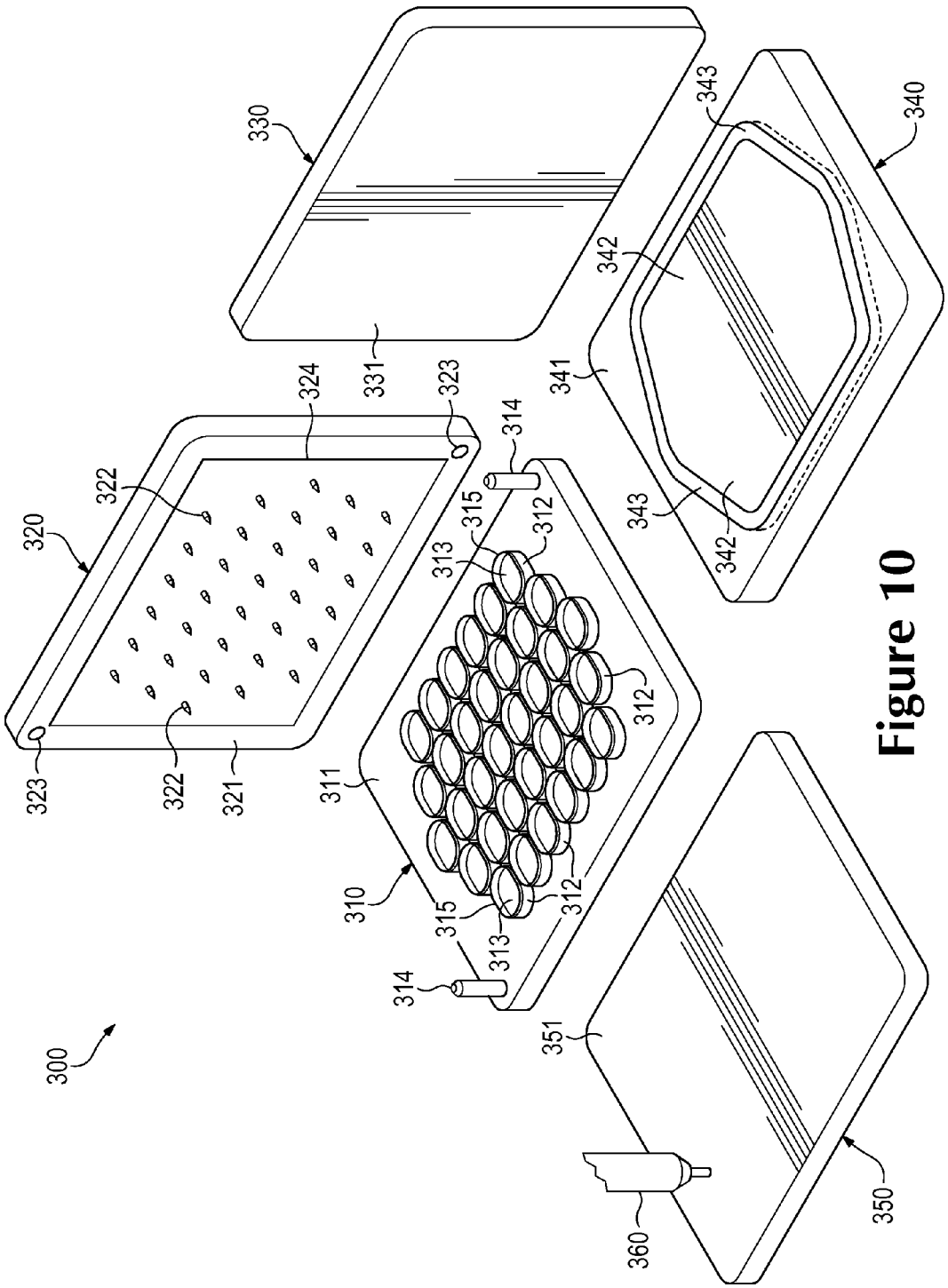
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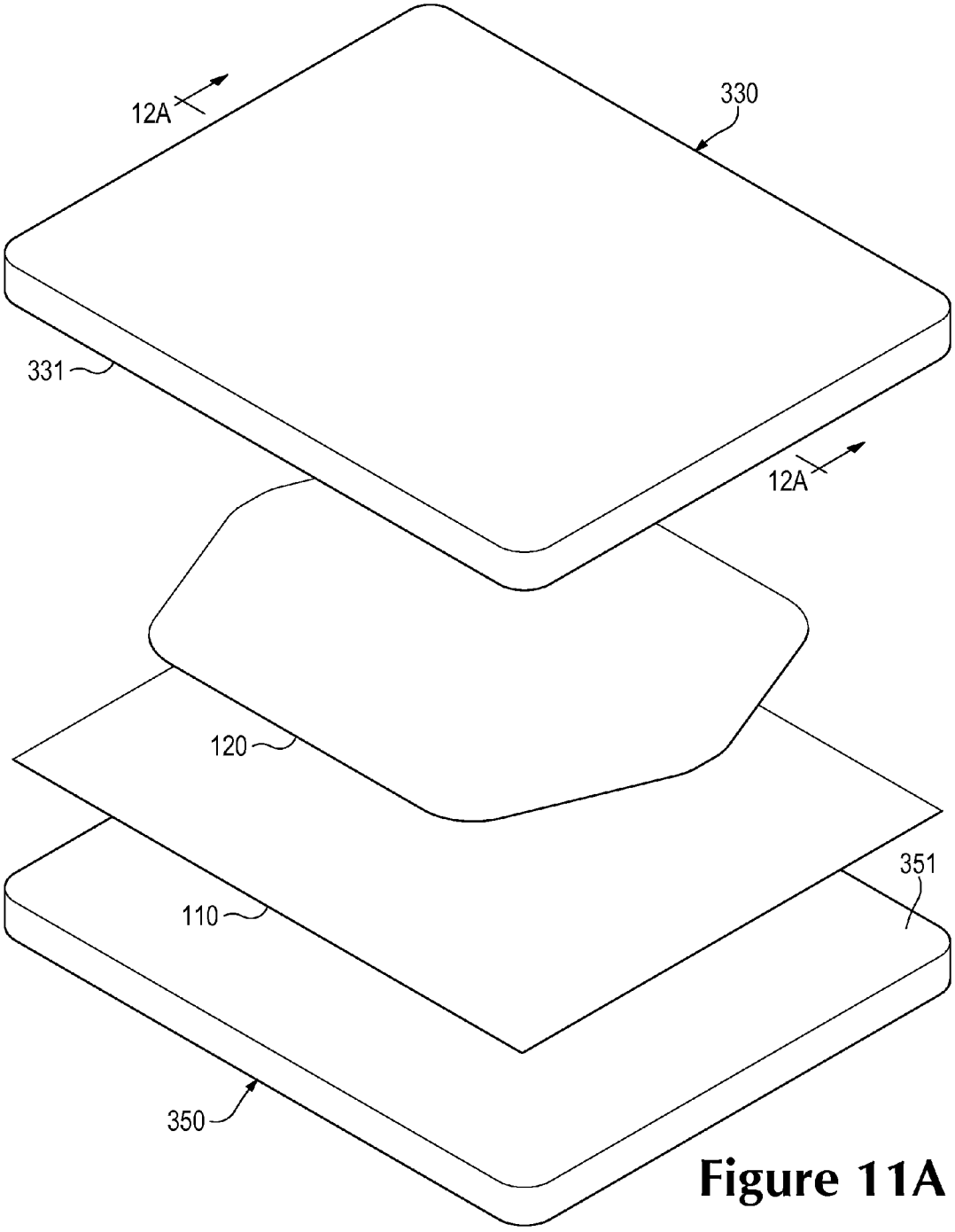
Figure 10



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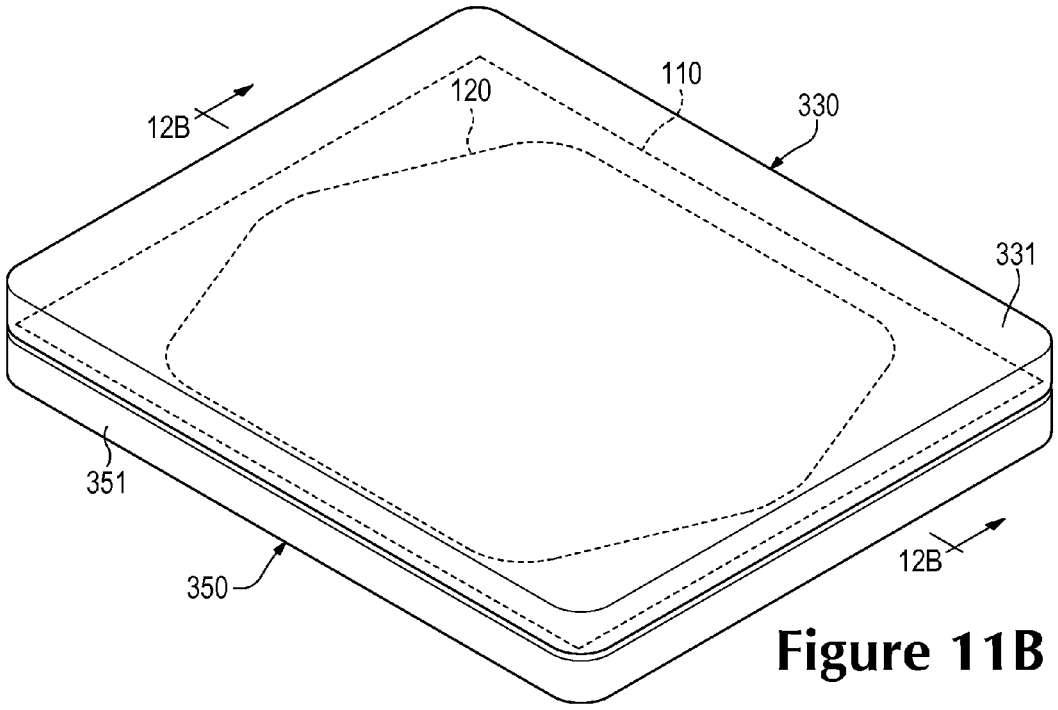

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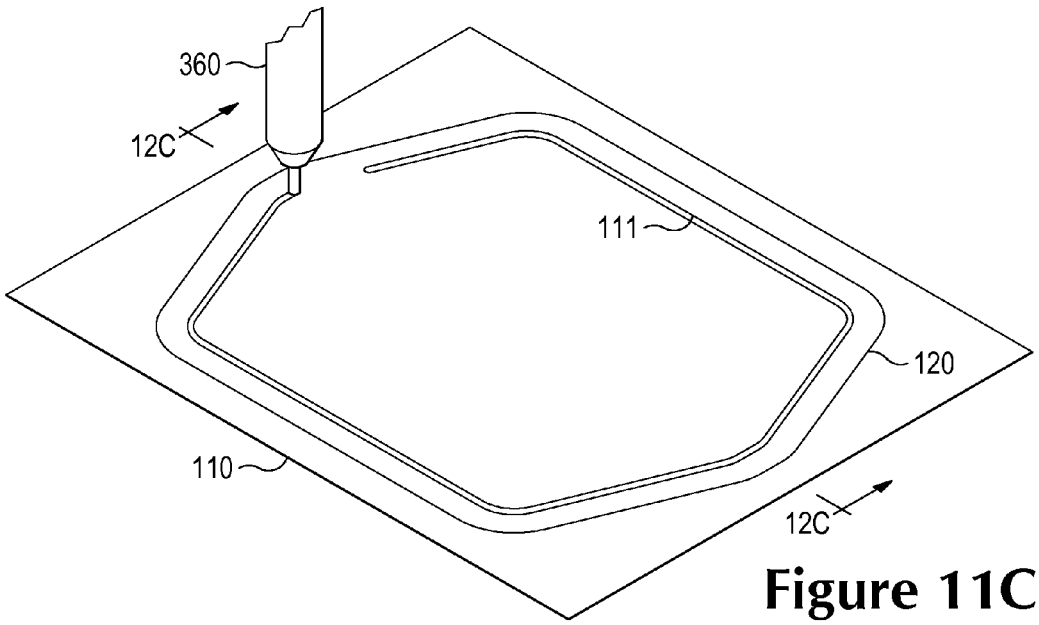

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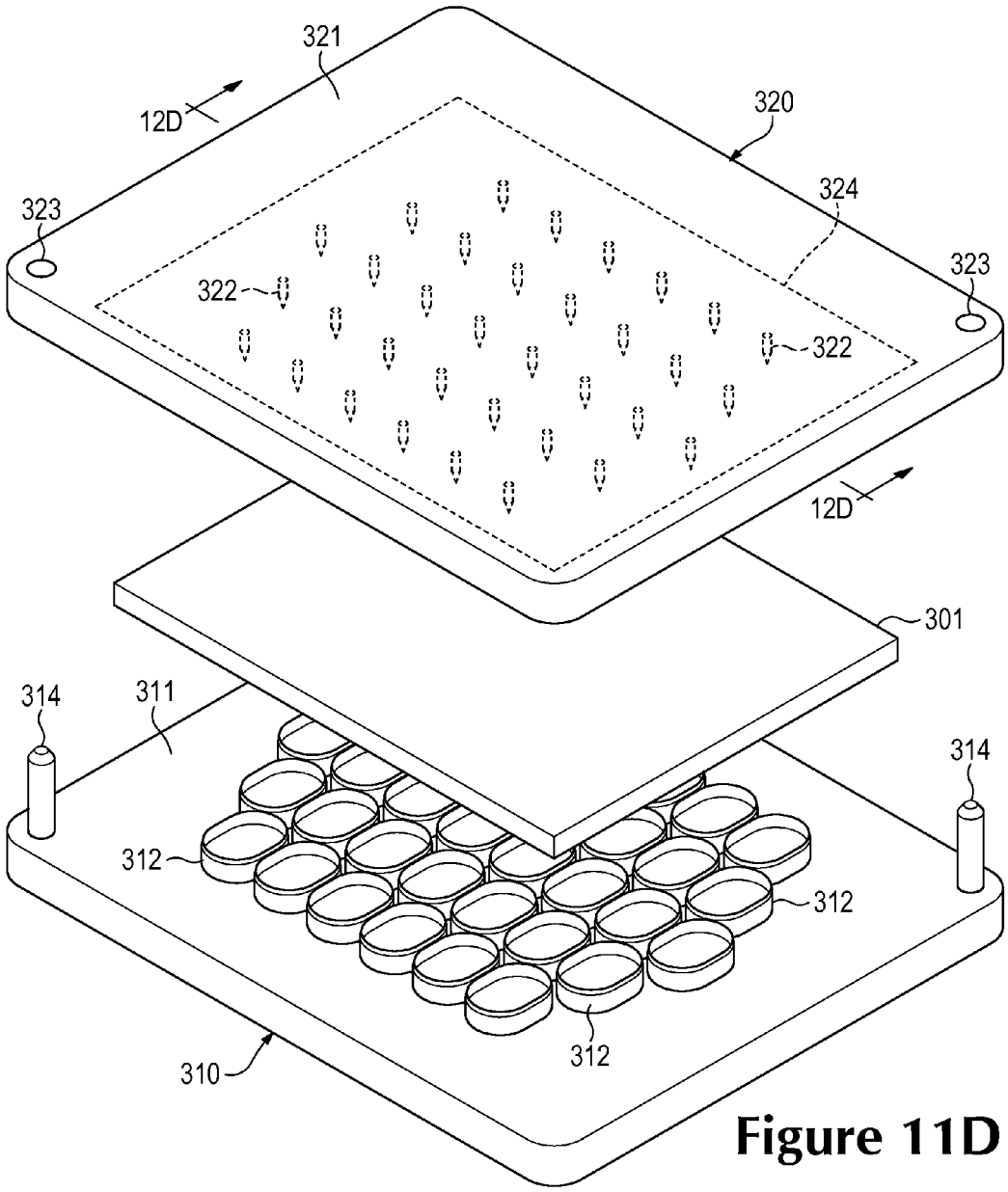
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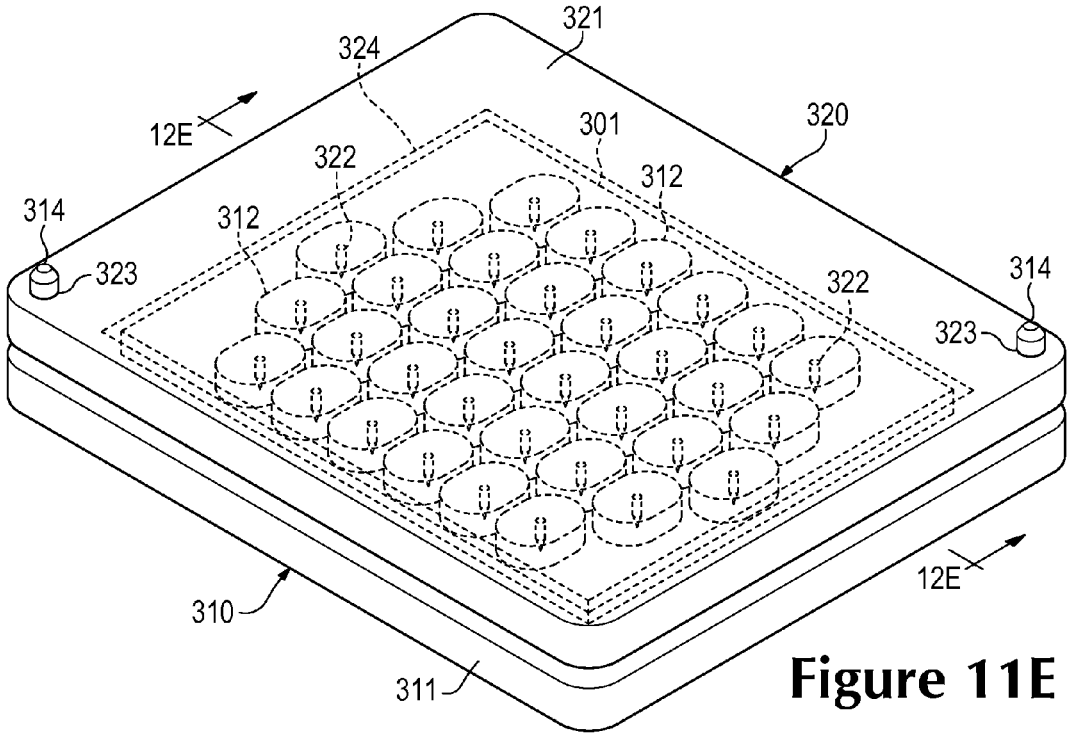

Figure 11E

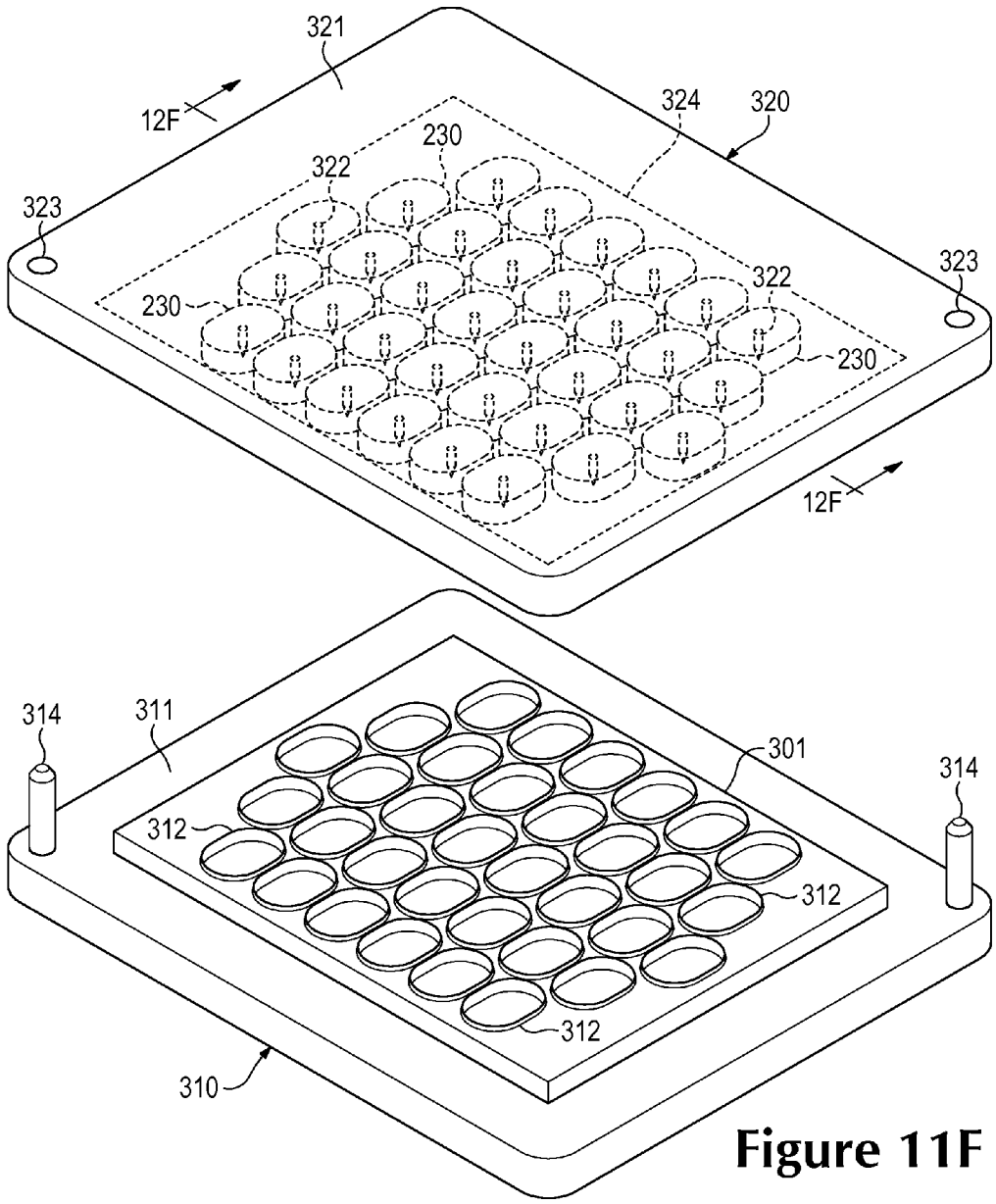
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Figure 11F

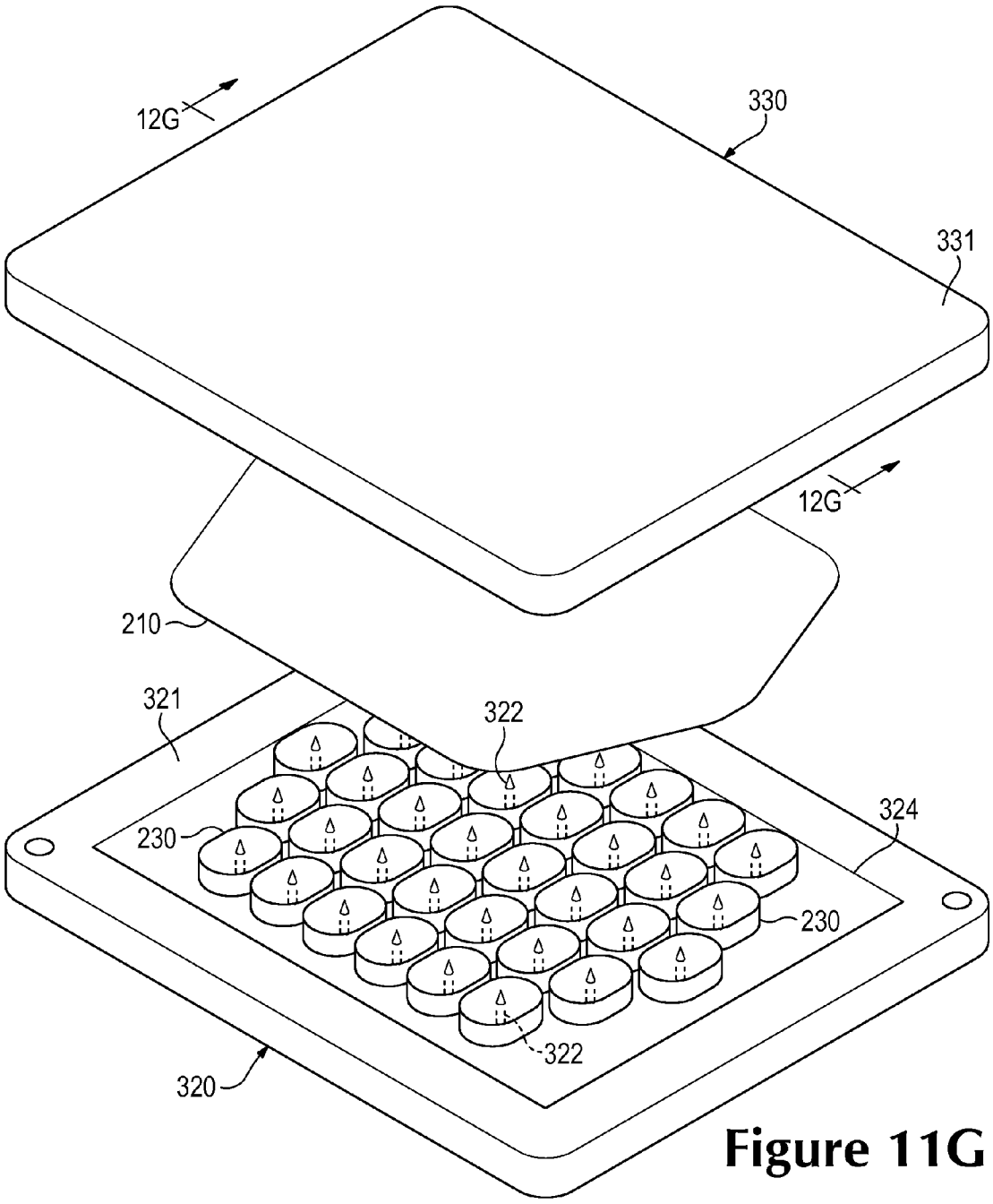

Figure 11G

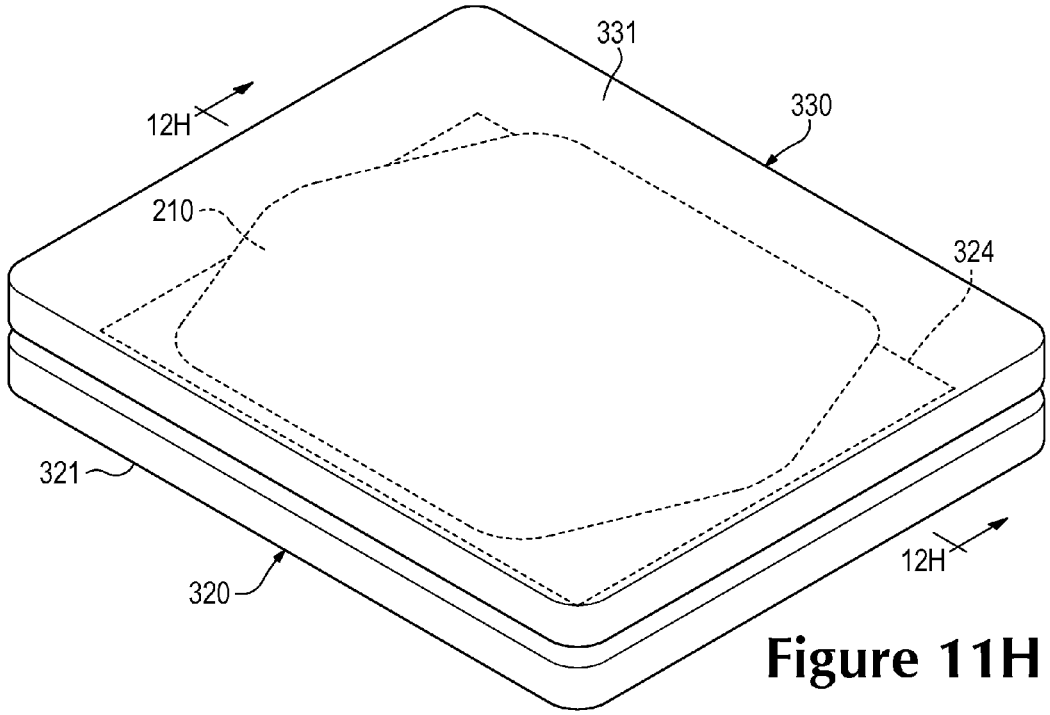

Figure 11H

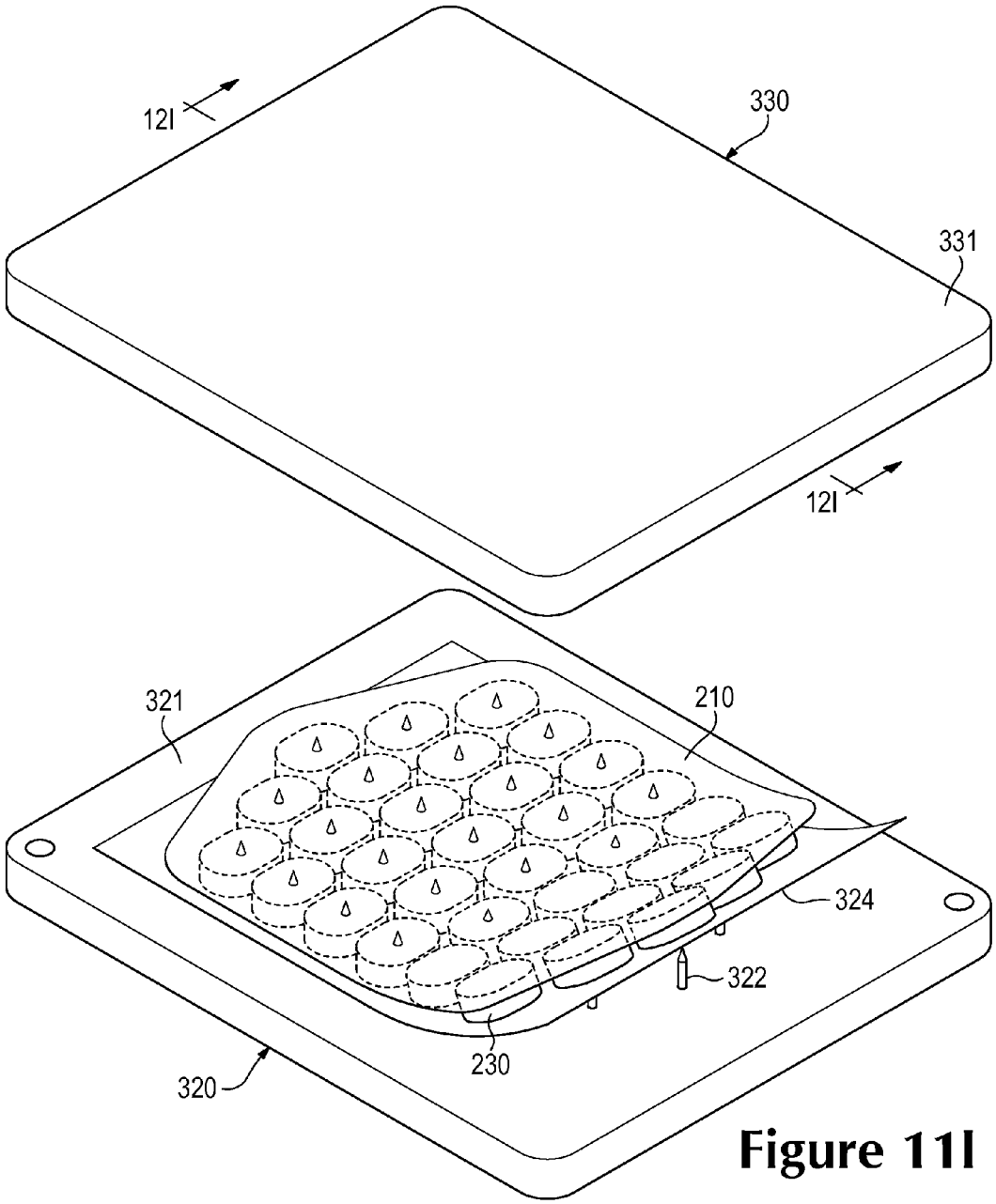

Figure 11l

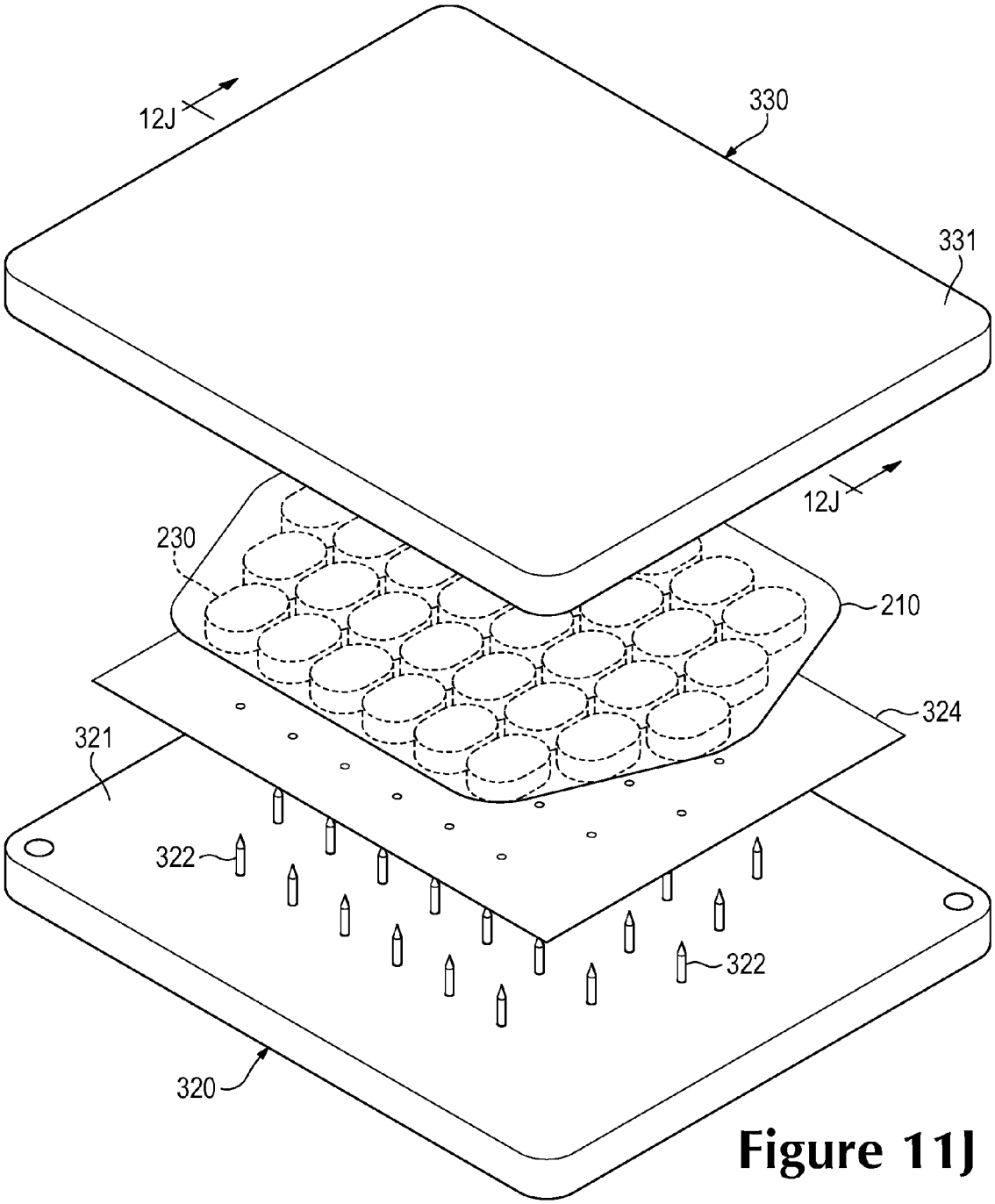

Figure 11J

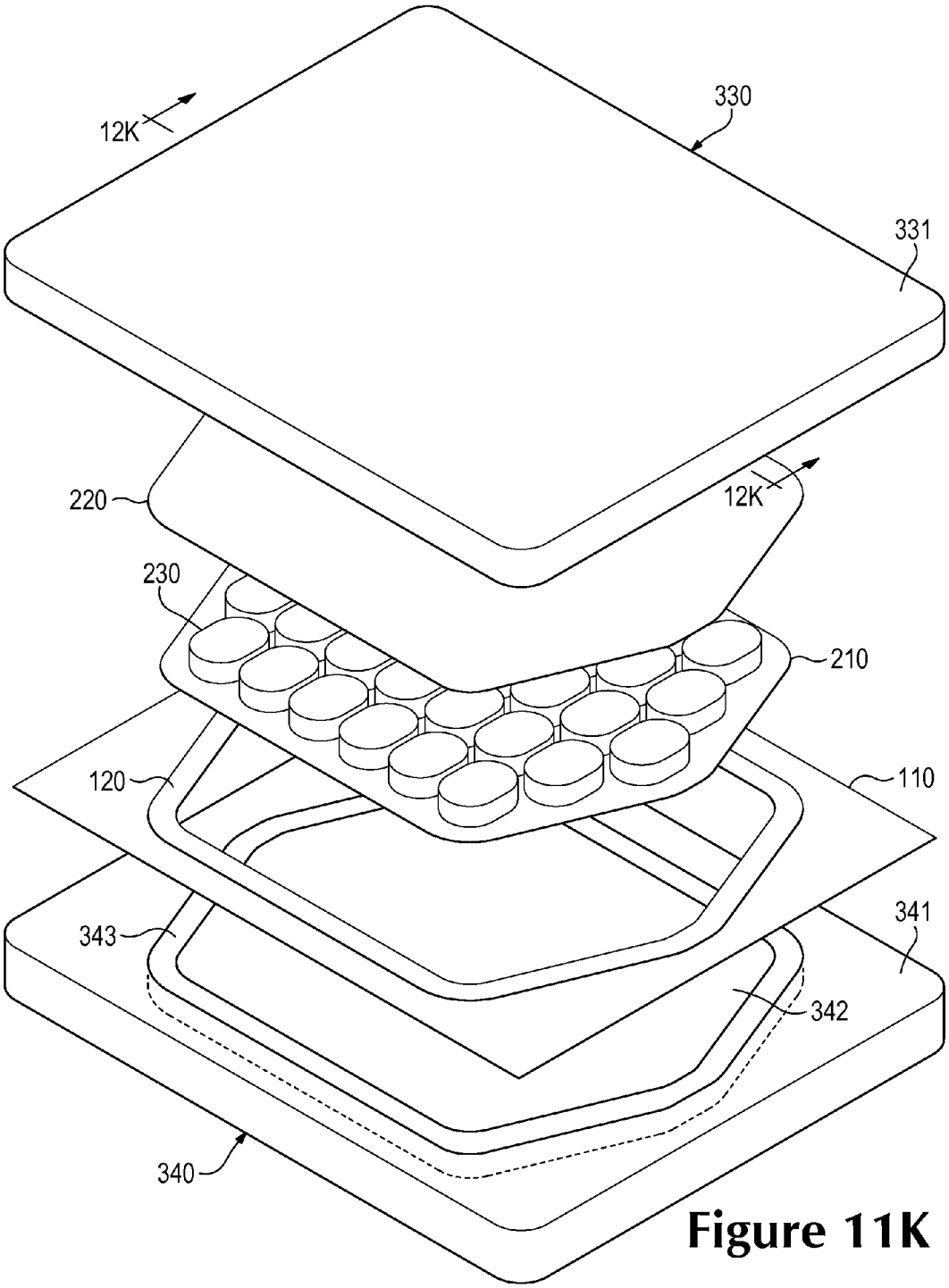

Figure 11K

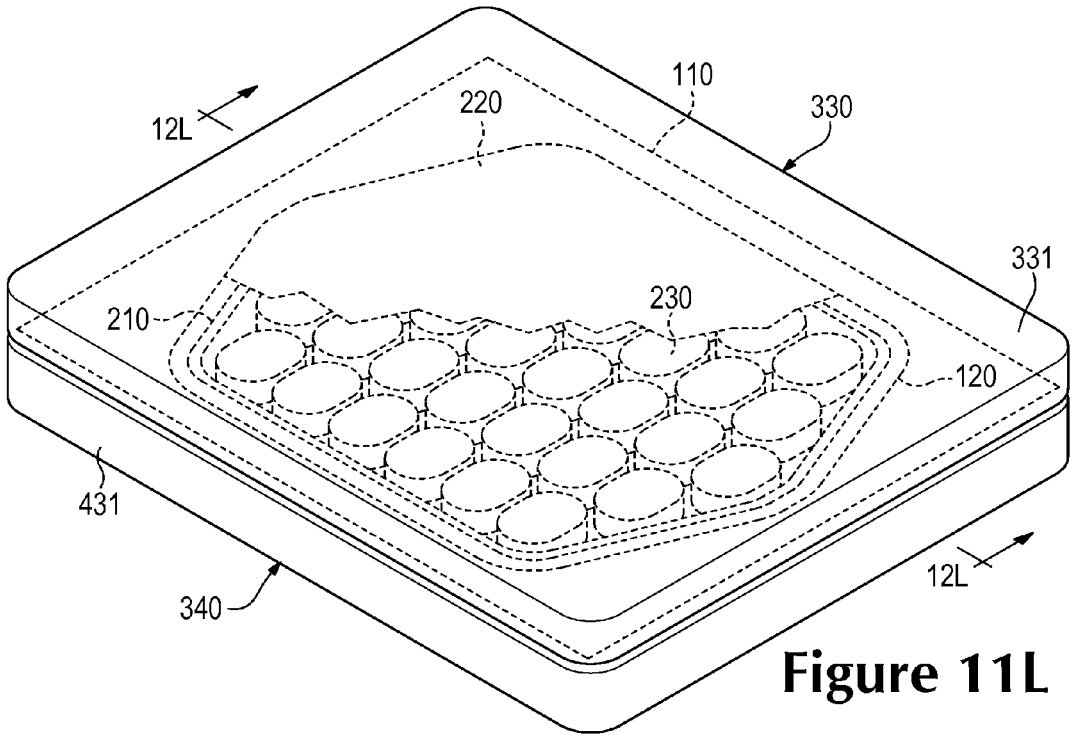

Figure 11L

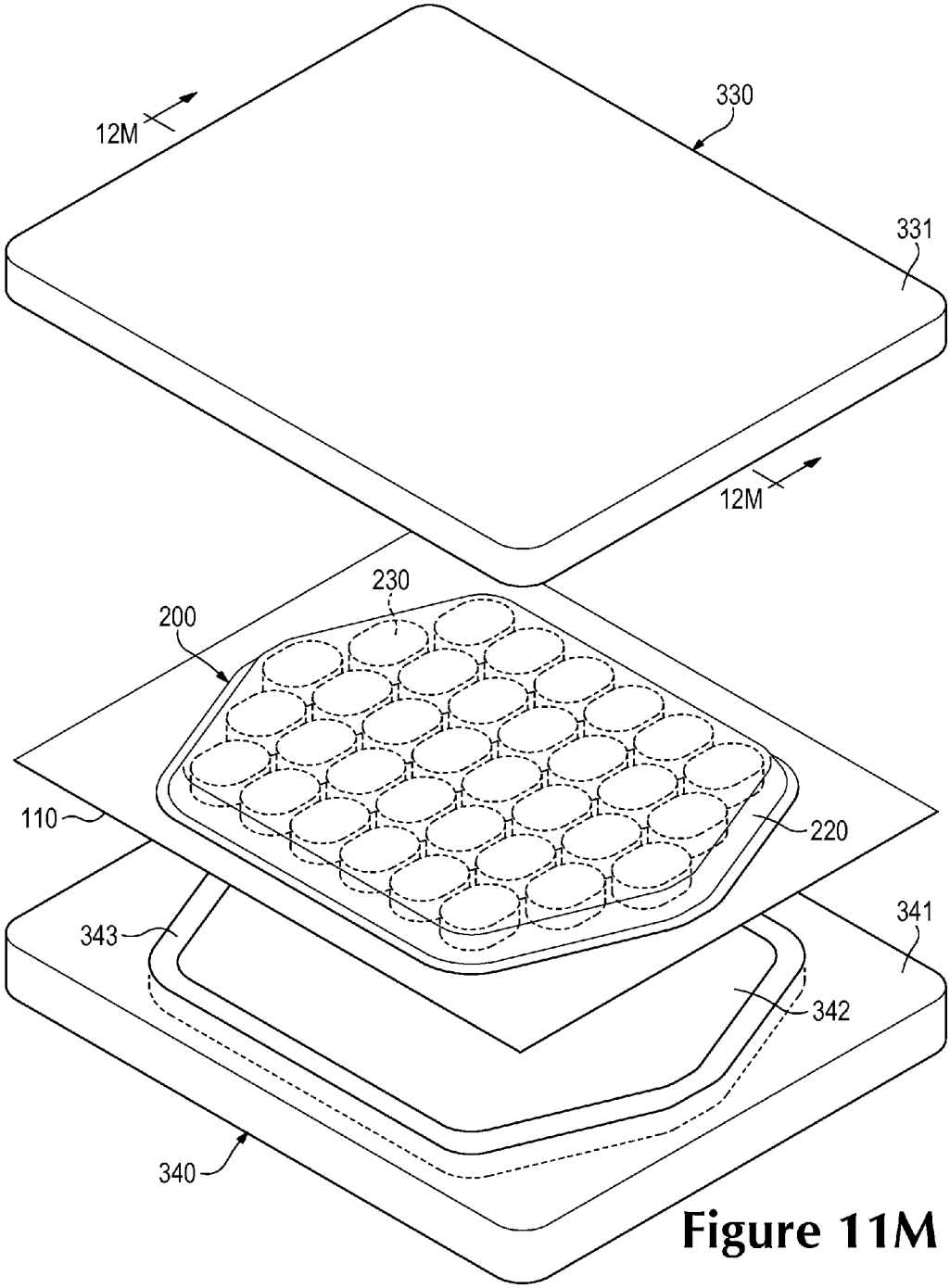

Figure 11M

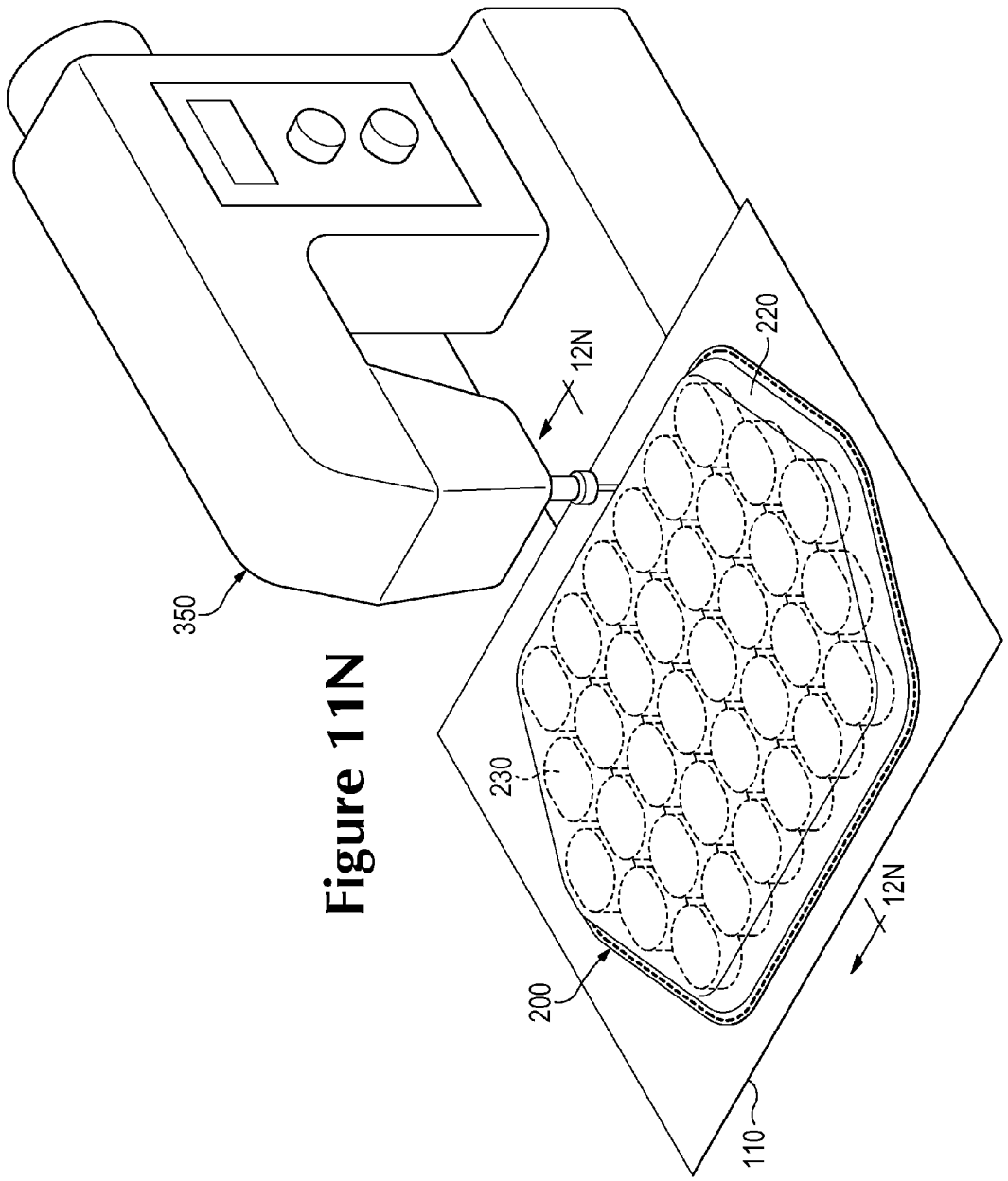

Figure 11N

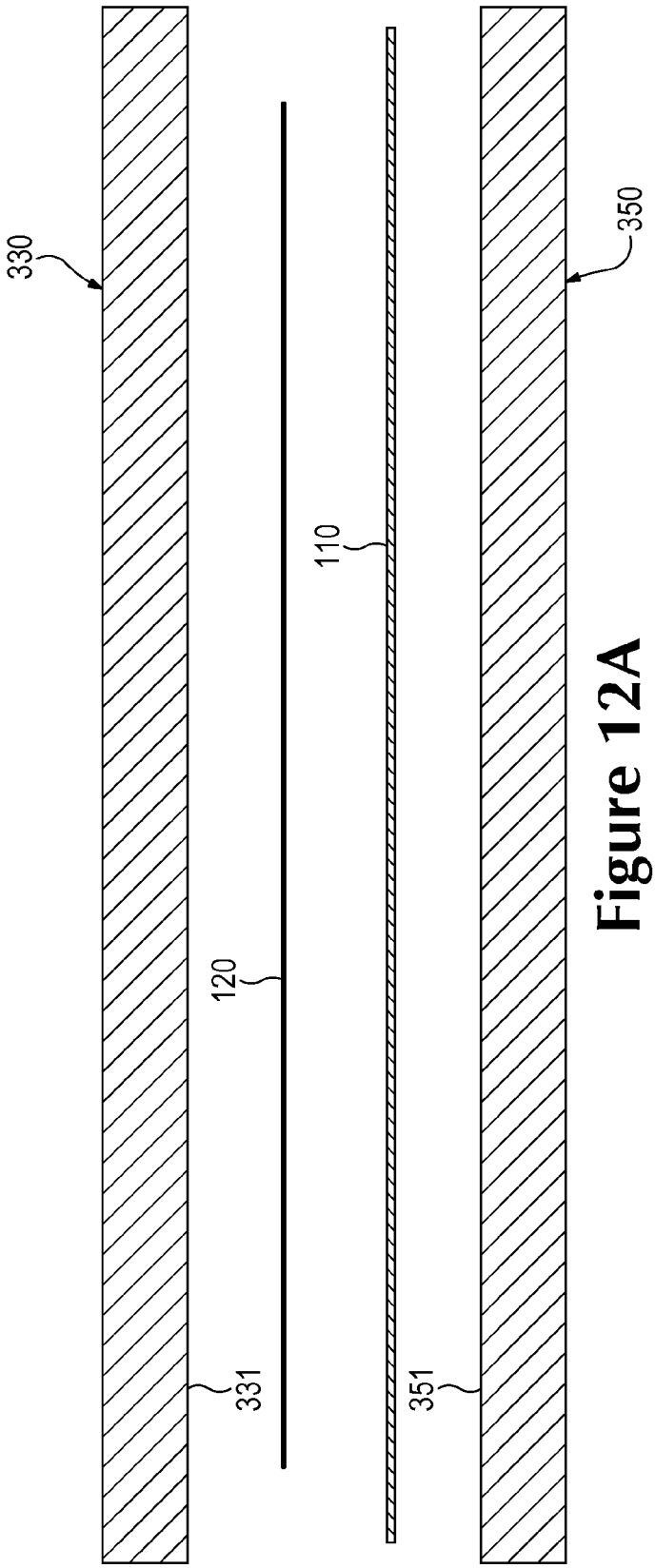

Figure 12A

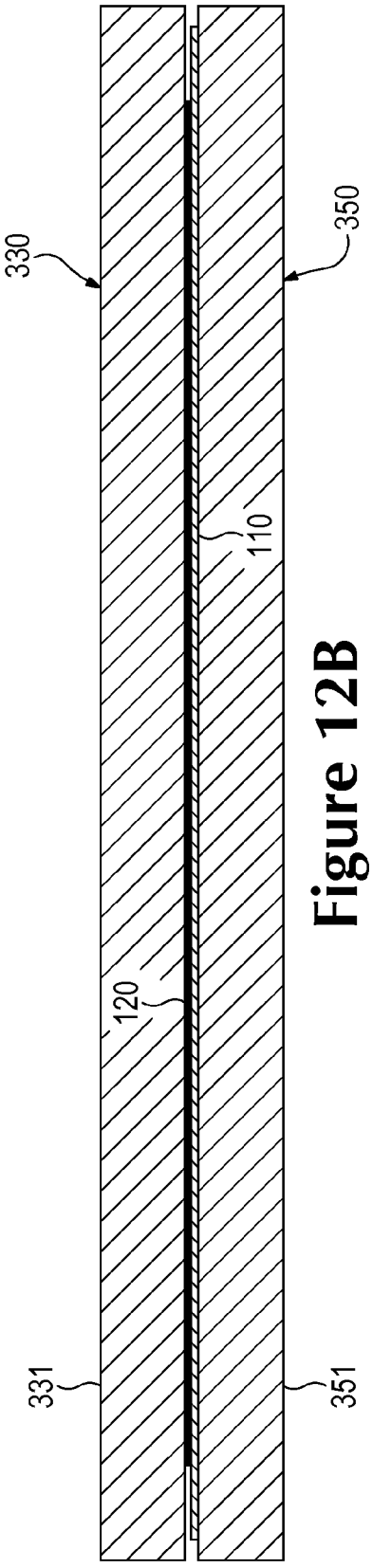

Figure 12B

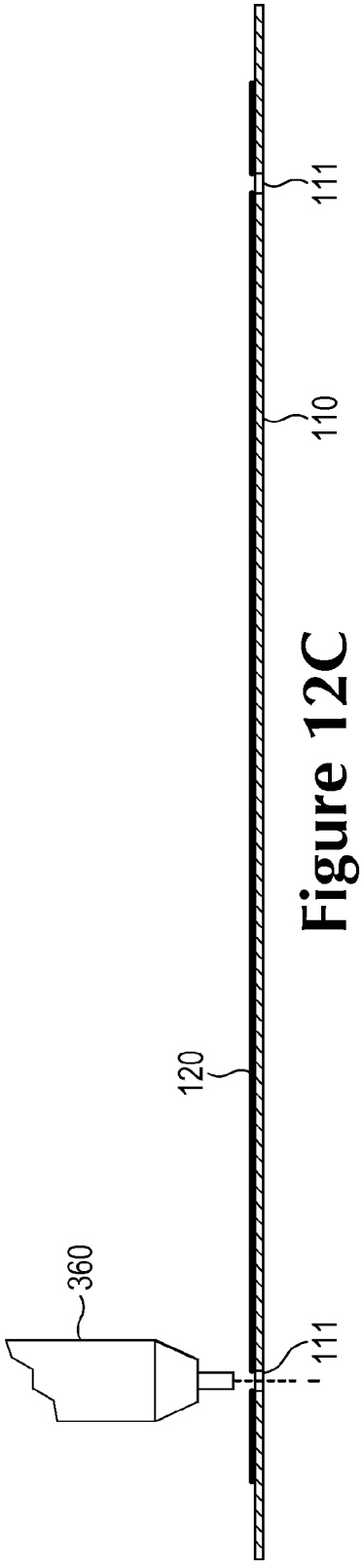

Figure 12C

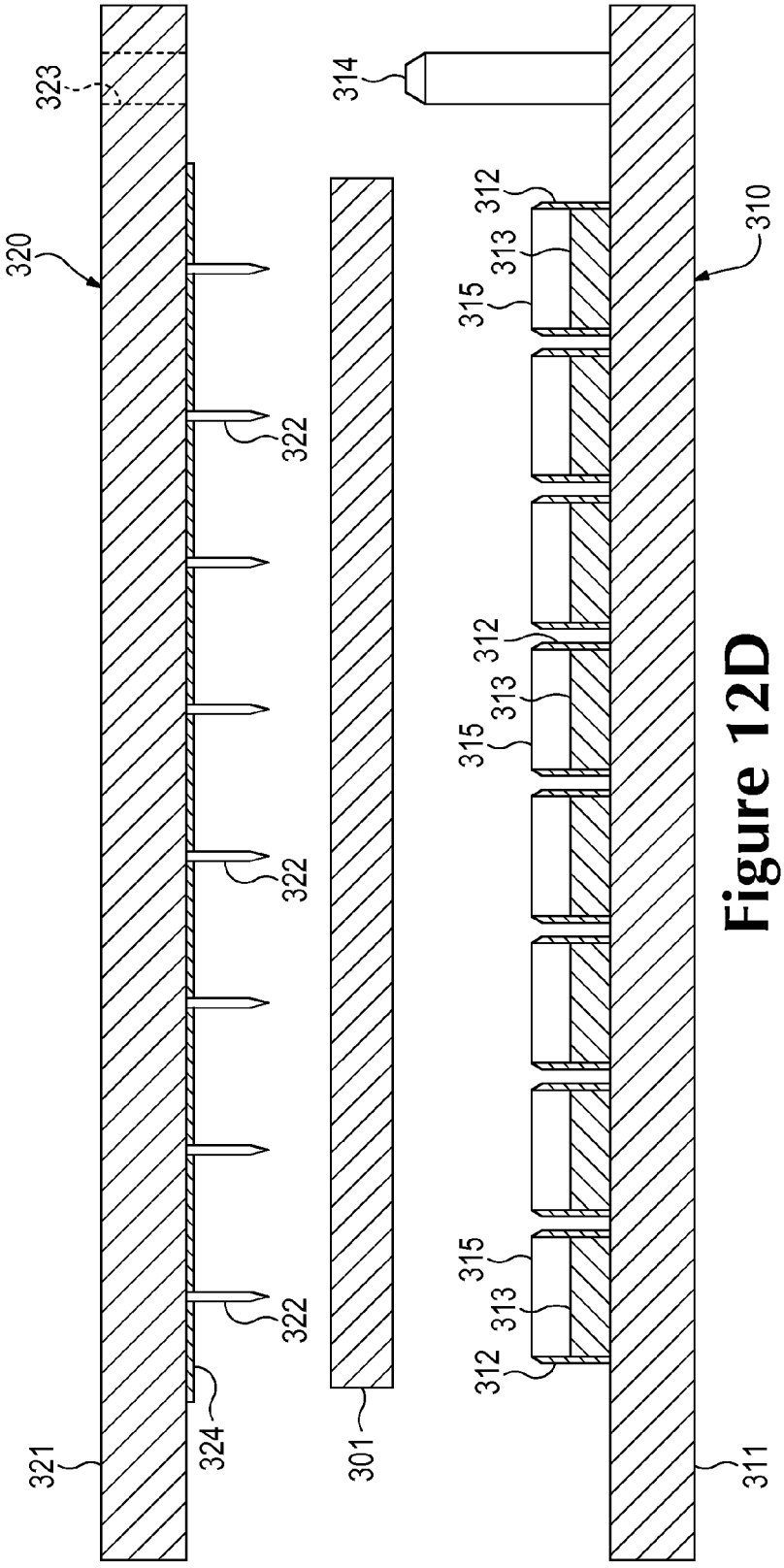

Figure 12D

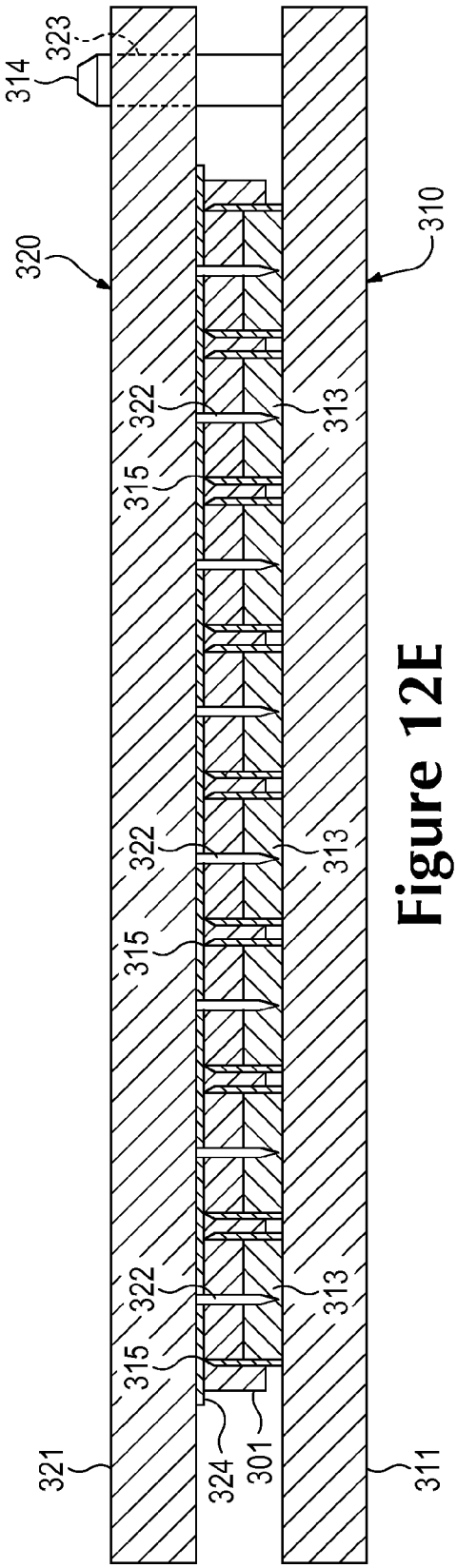
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Figure 12E

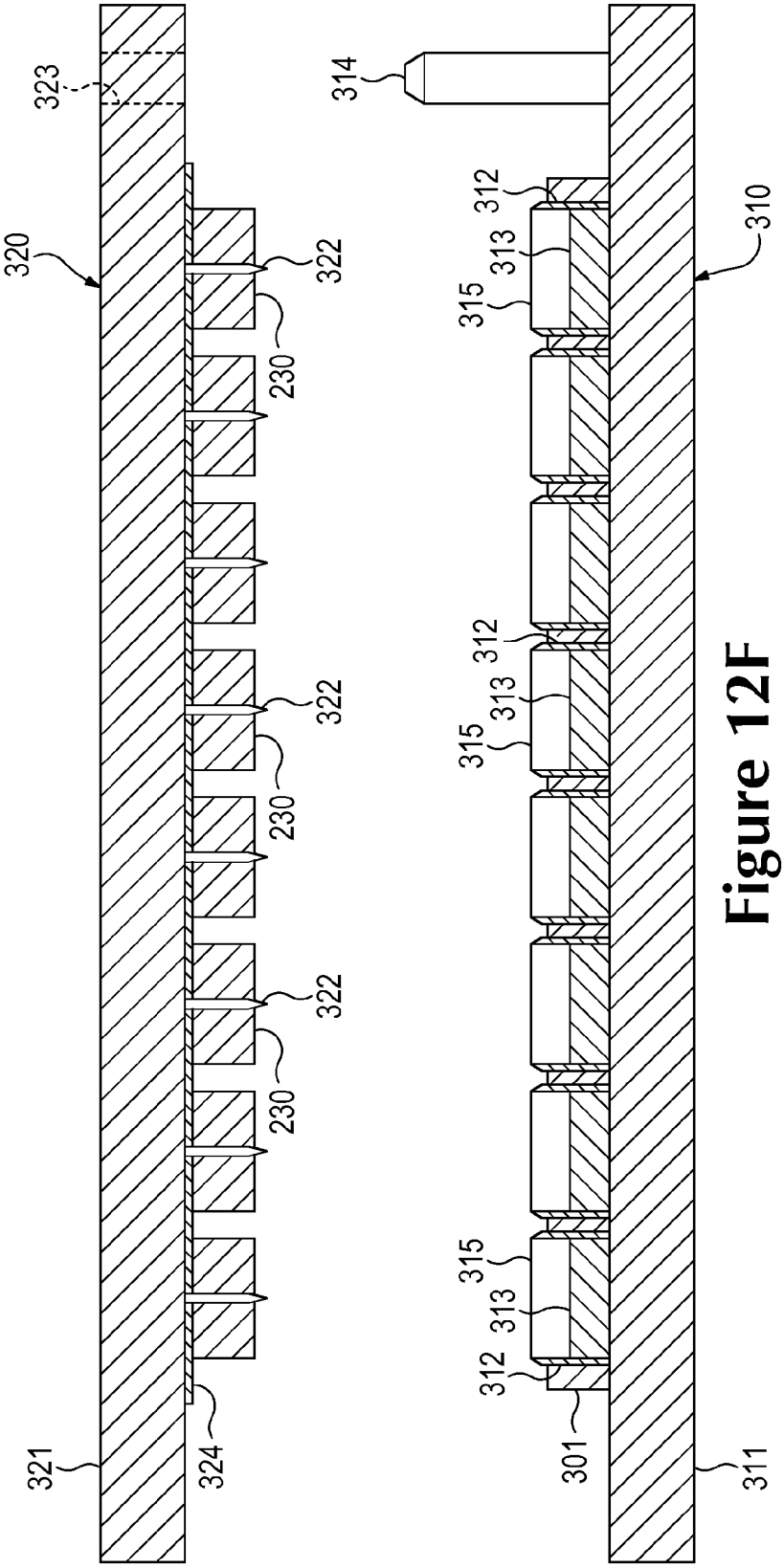
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Figure 12F

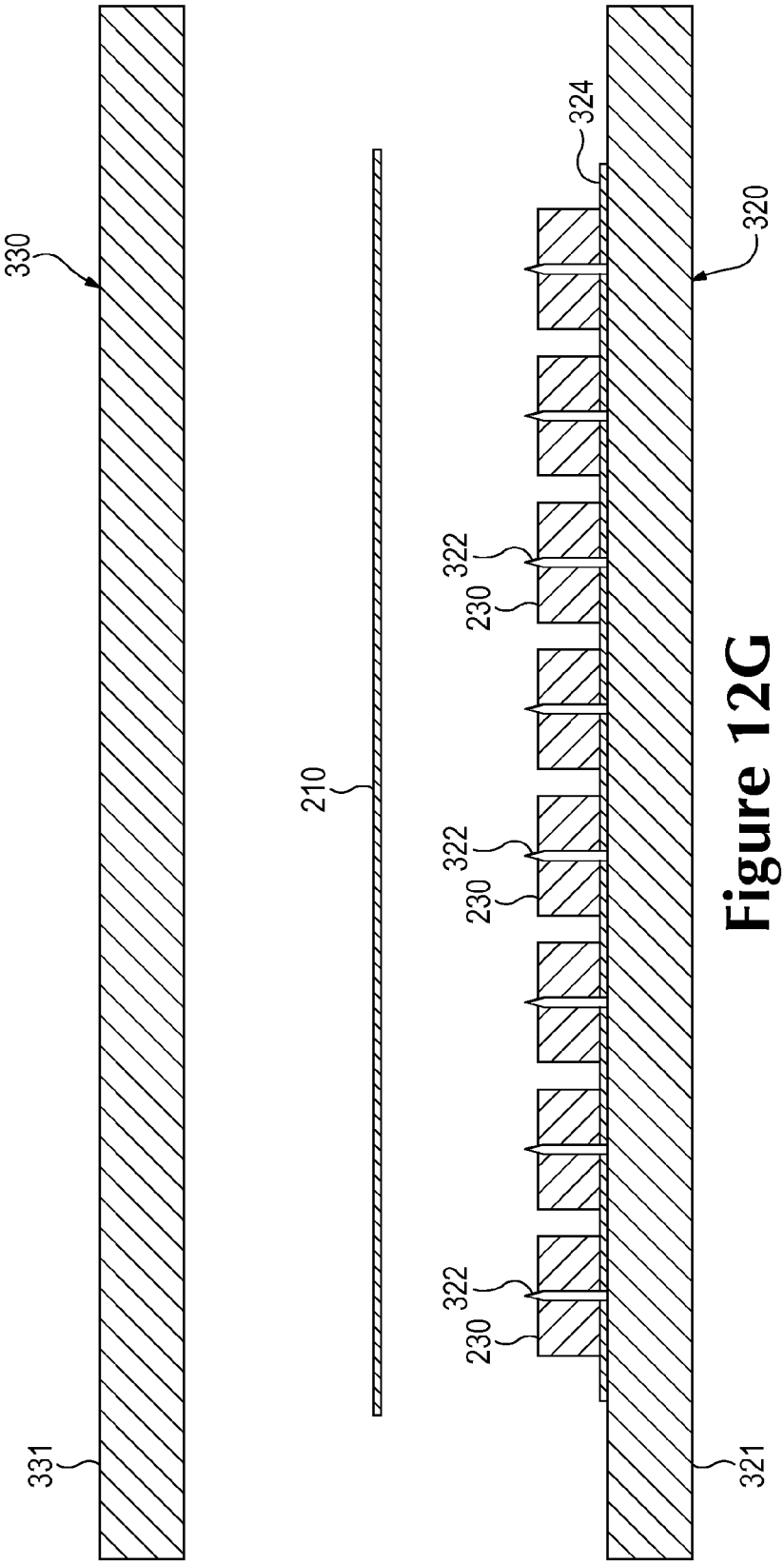

Figure 12G

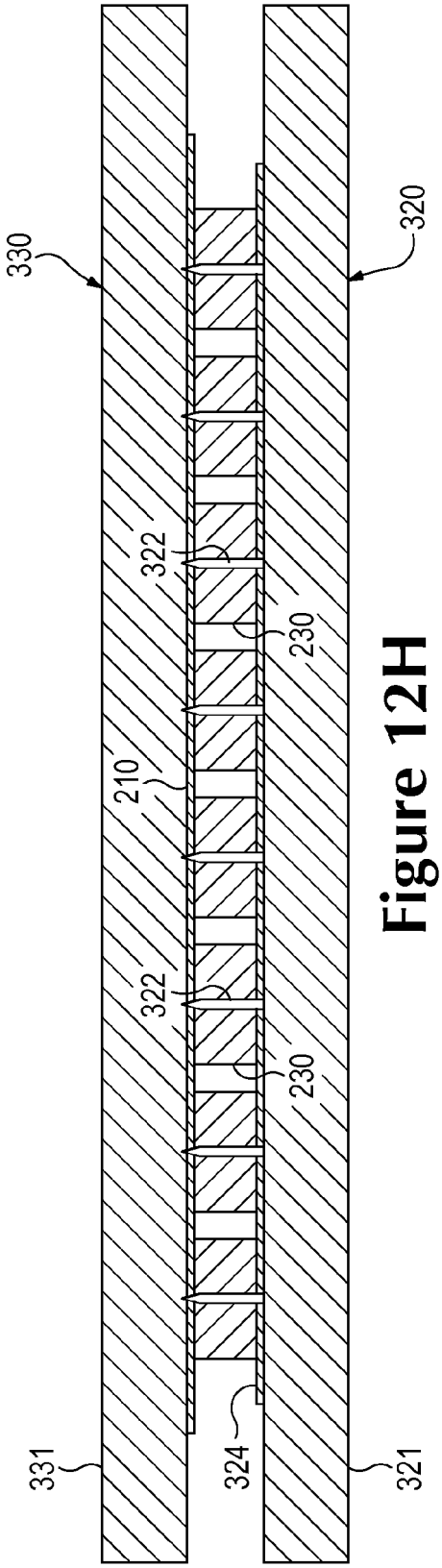

Figure 12H

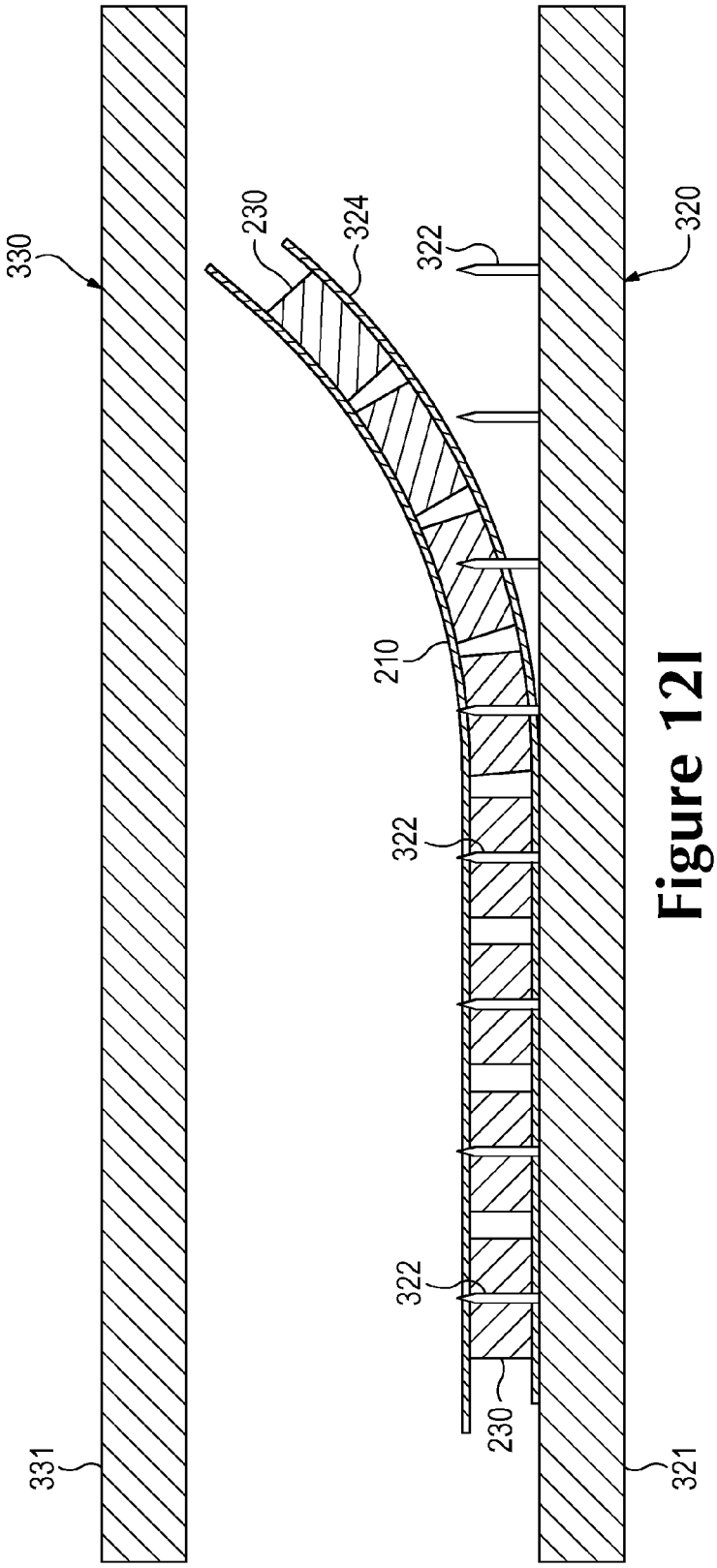

Figure 12I

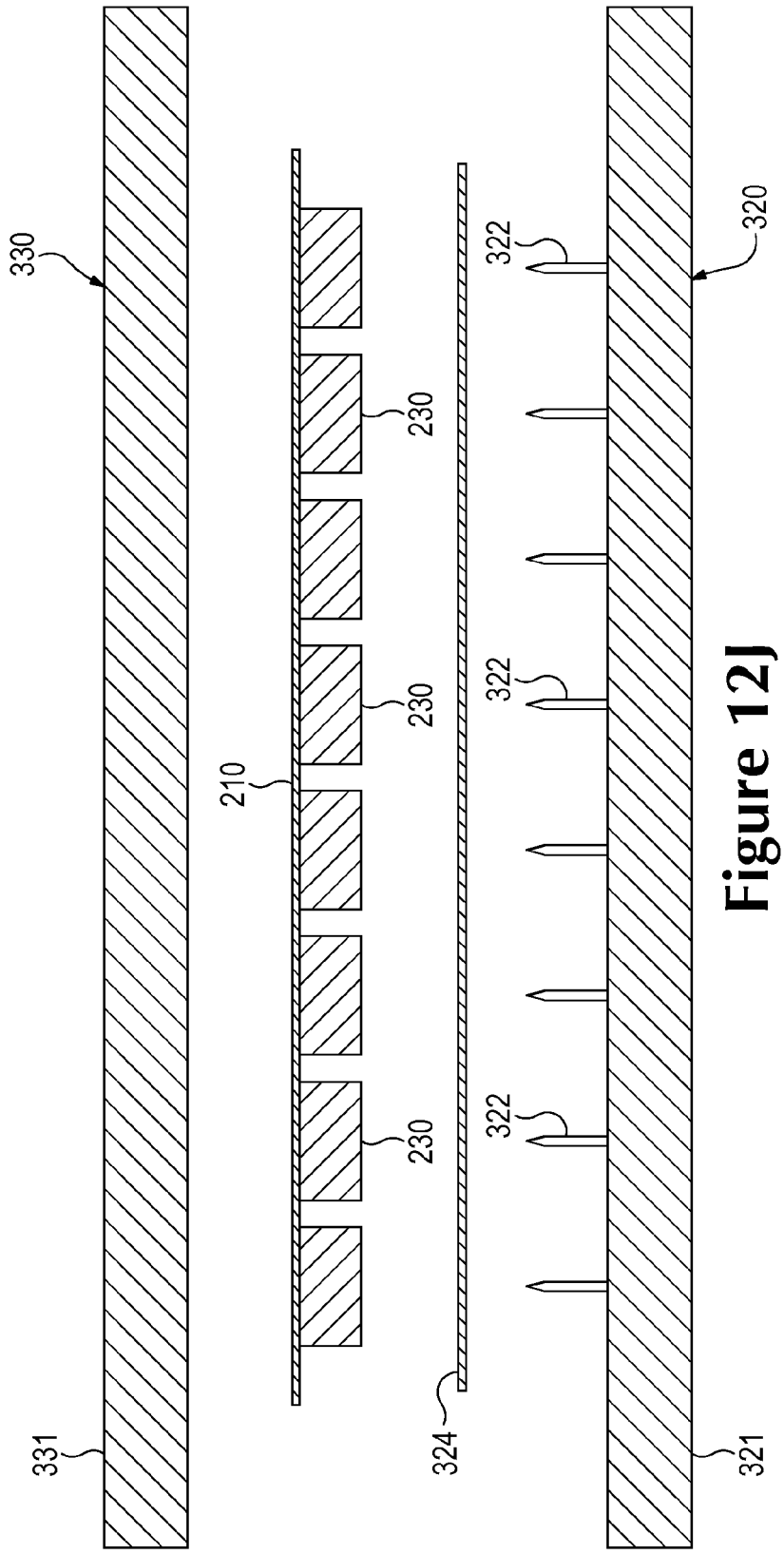

Figure 12J

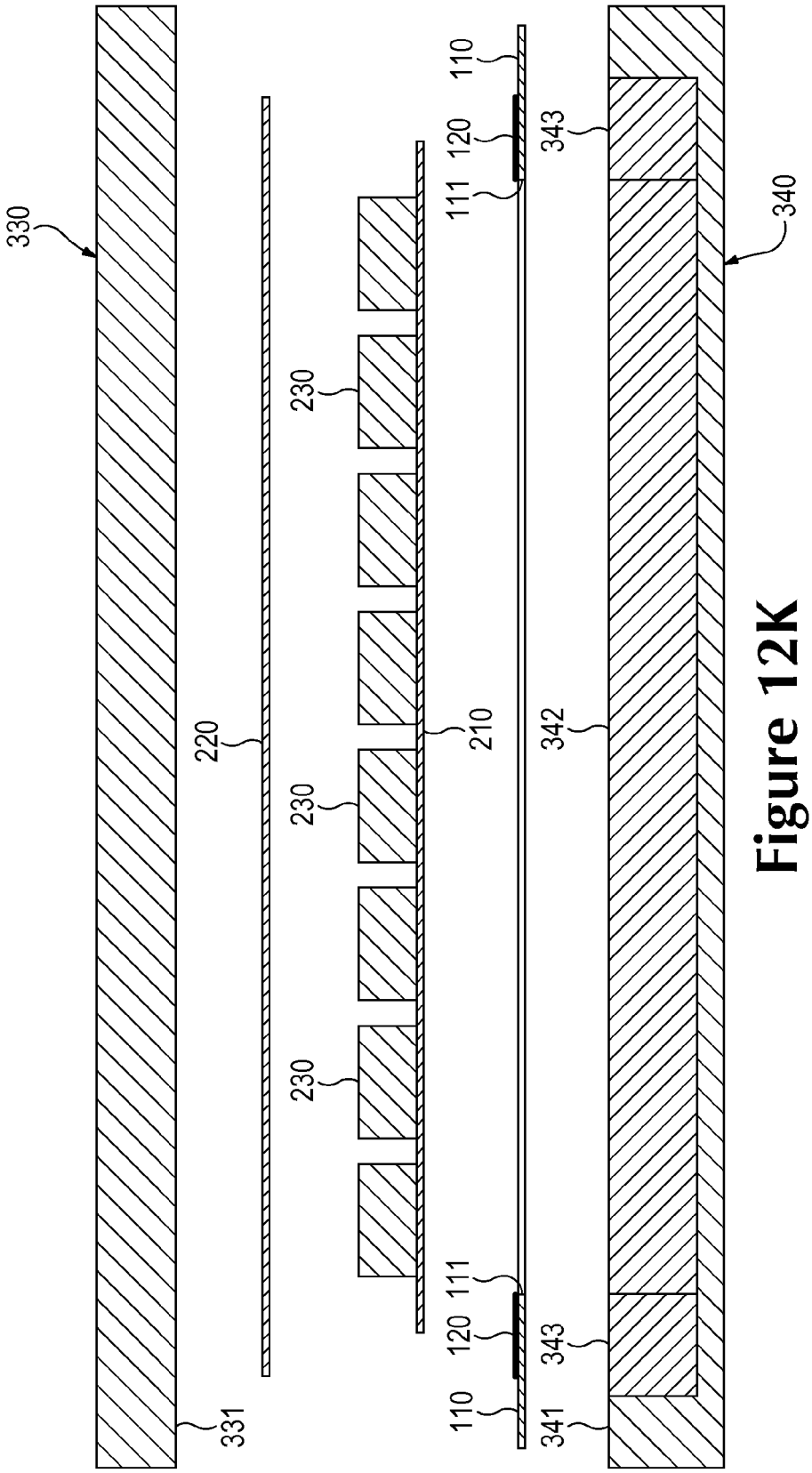
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Figure 12K

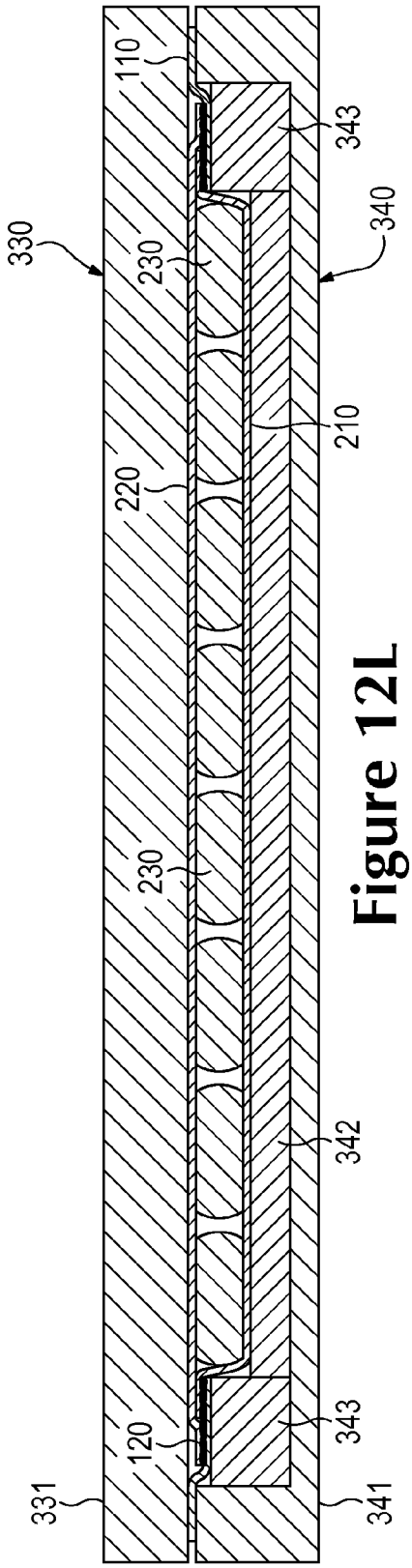

Figure 12L

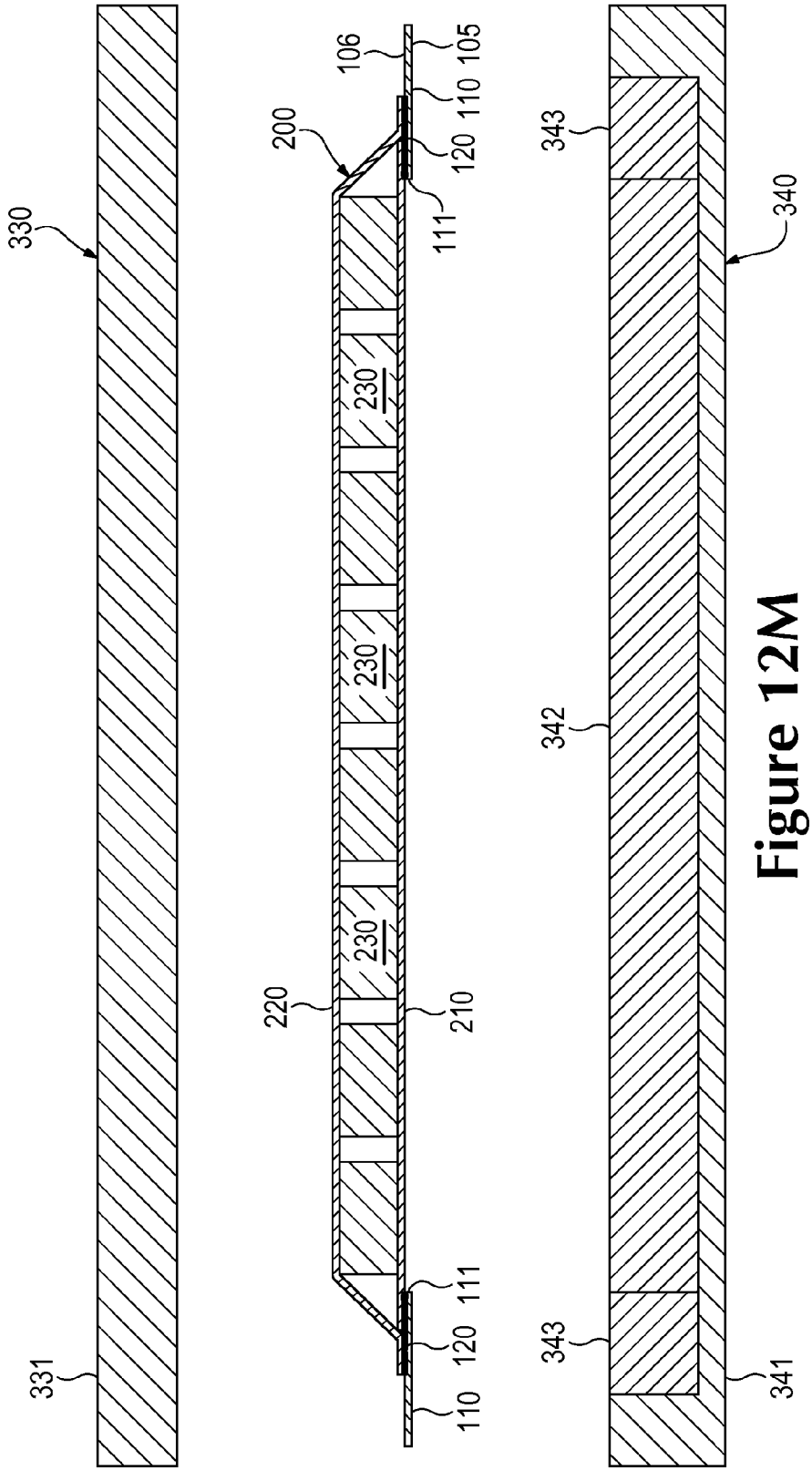
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Figure 12M

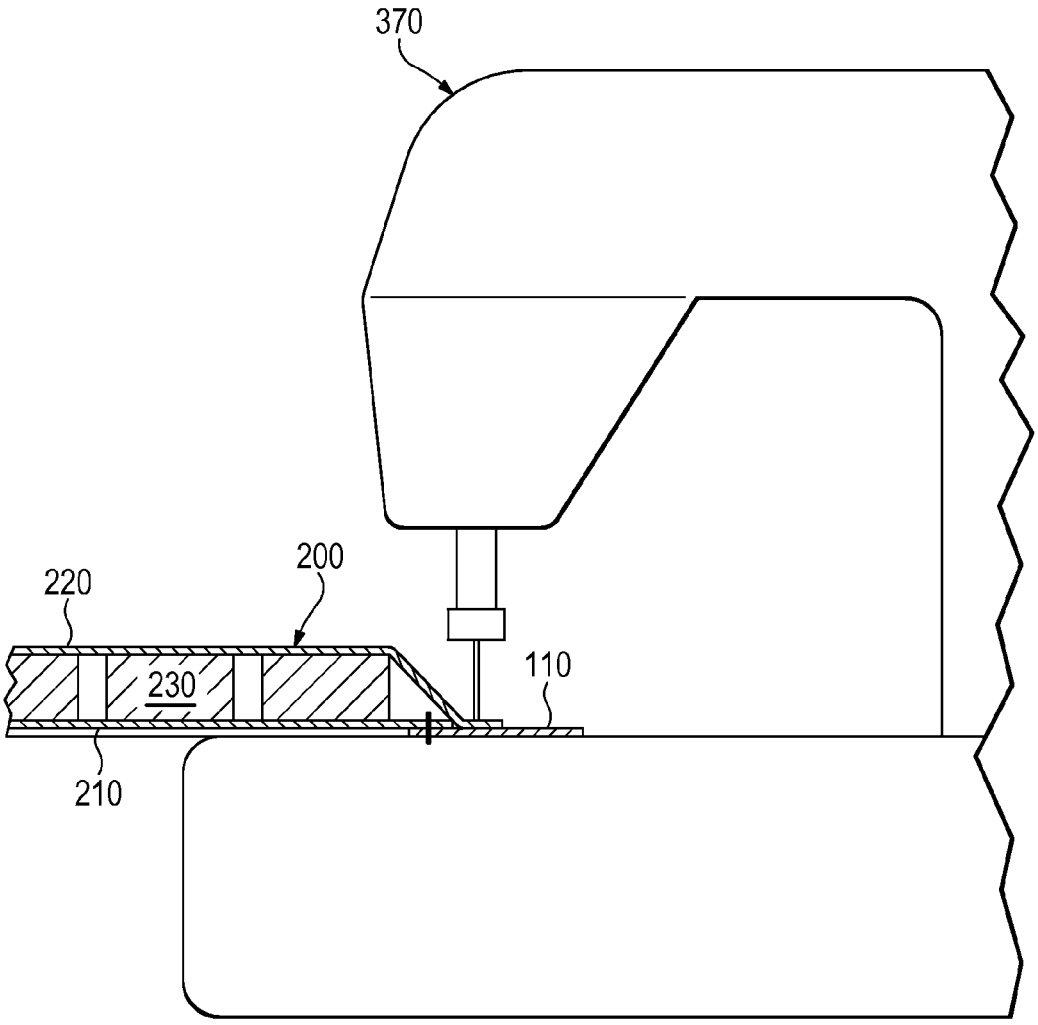

Figure 12N

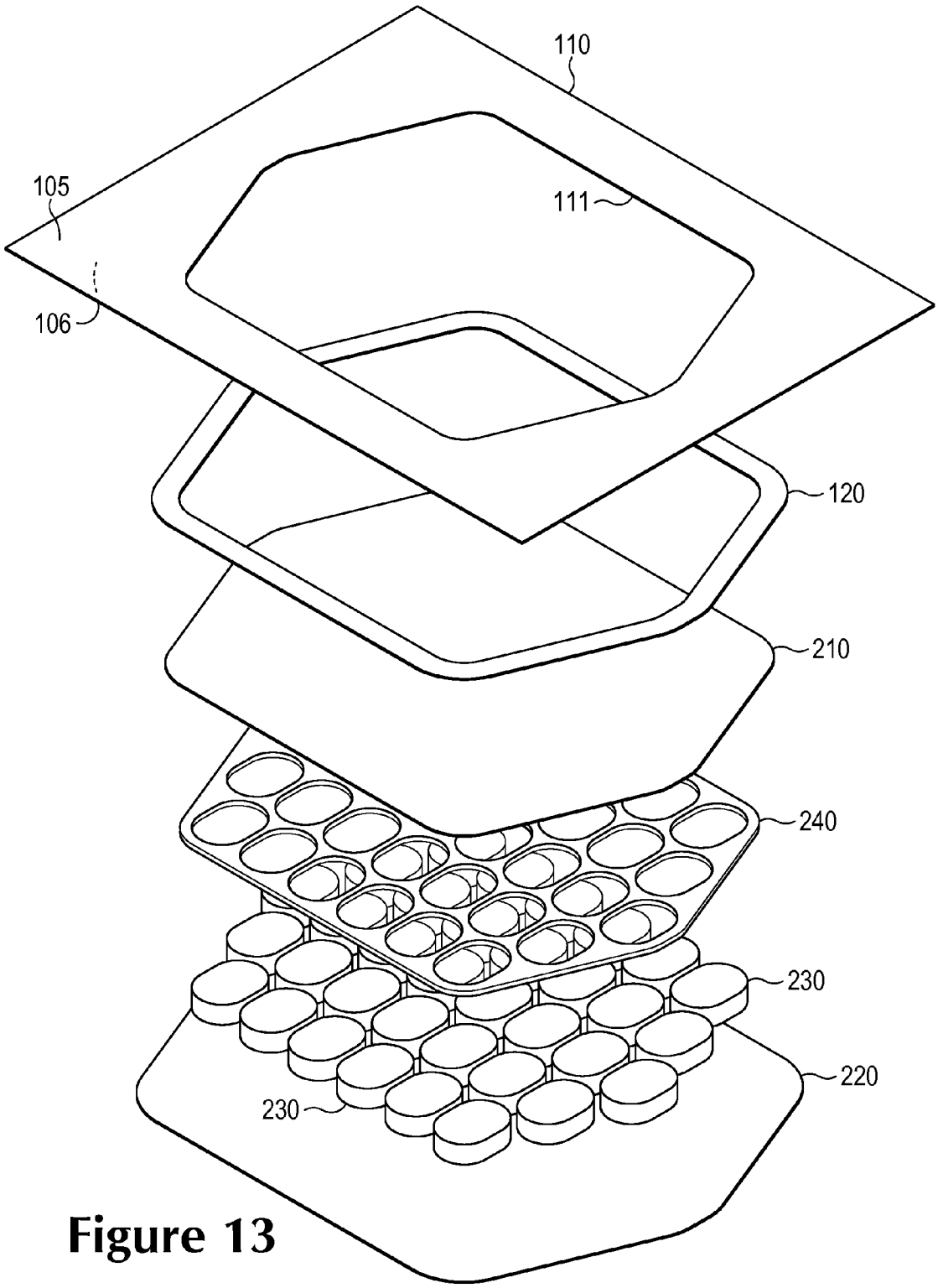

Figure 13

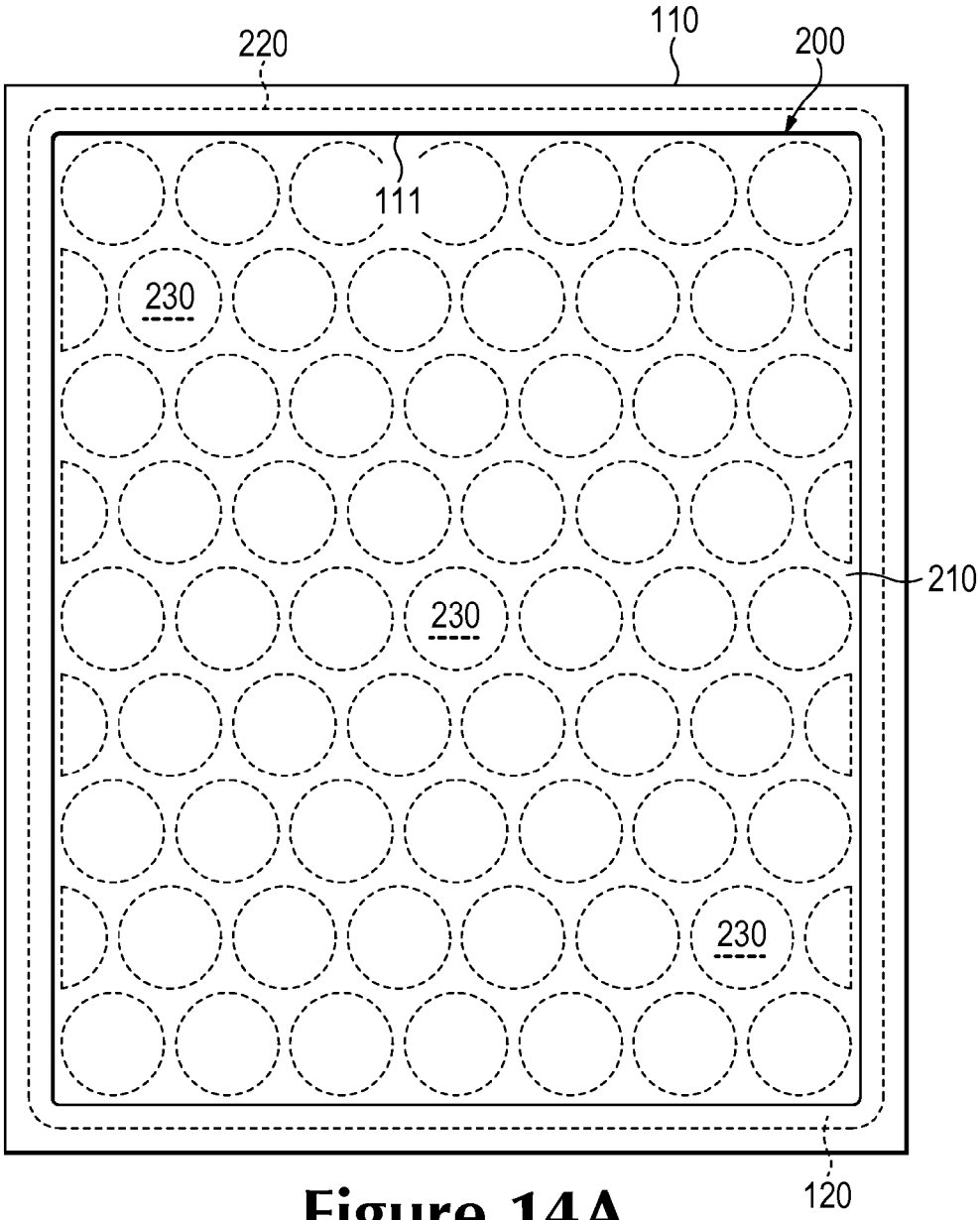

Figure 14A

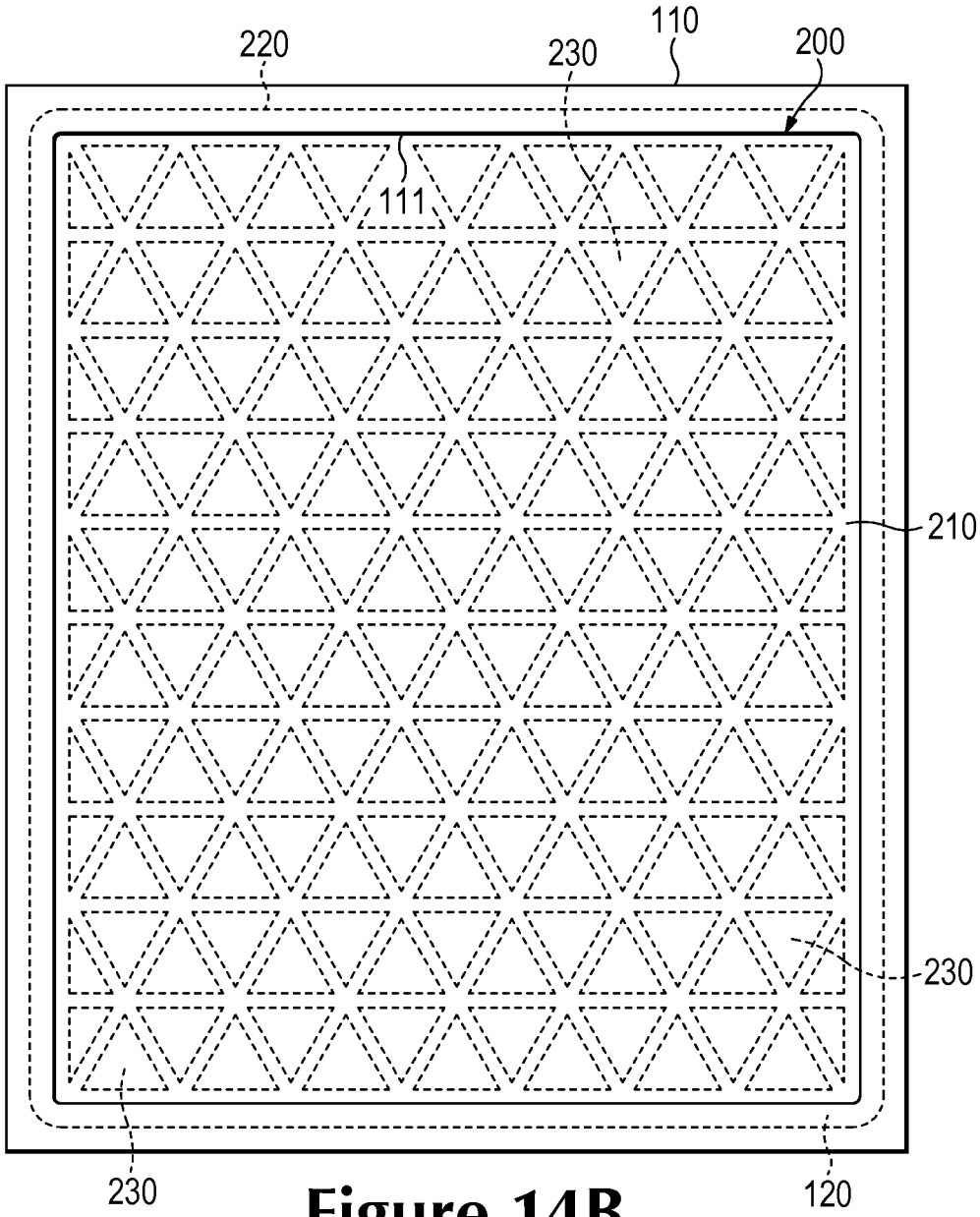

Figure 14B

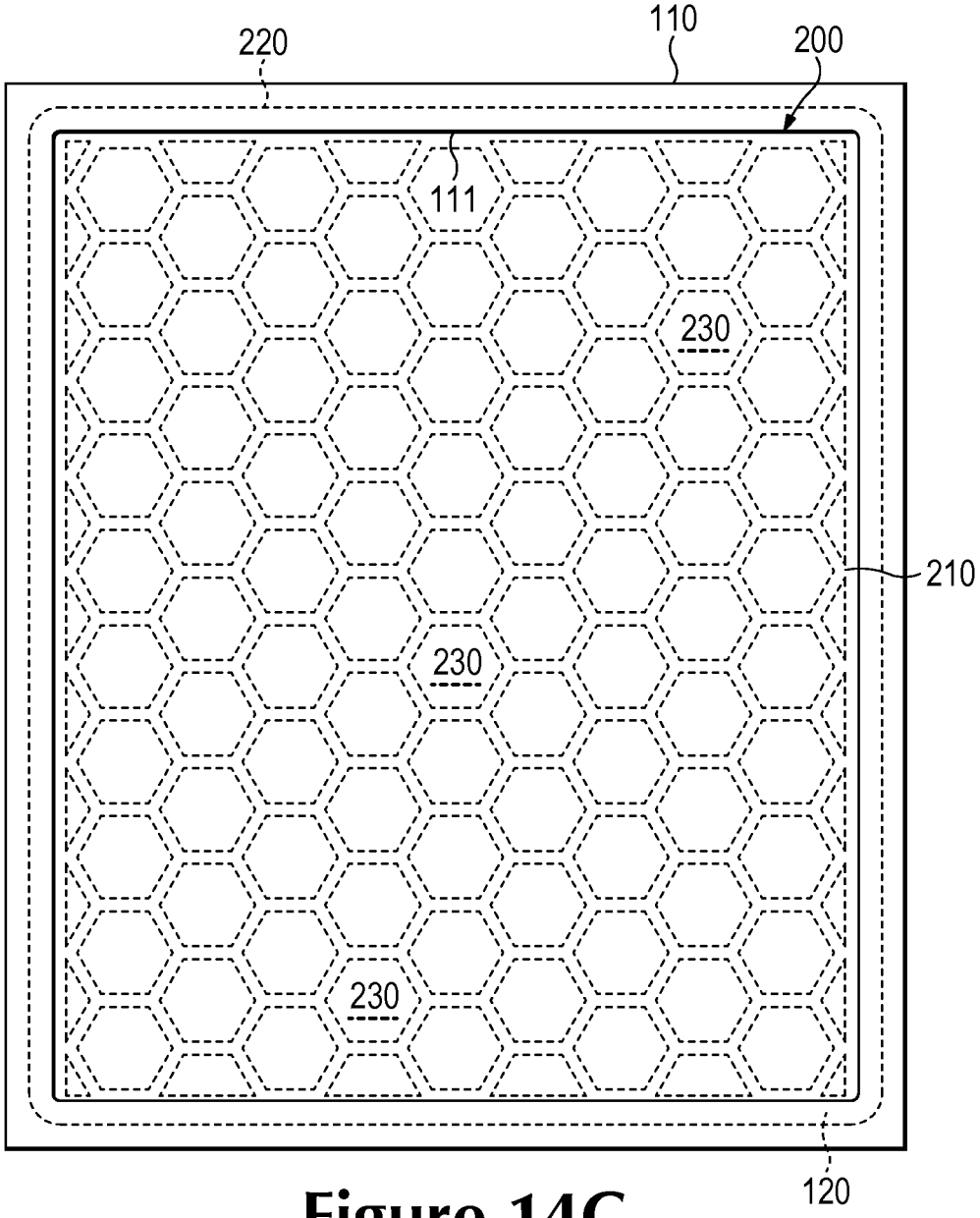

Figure 14C

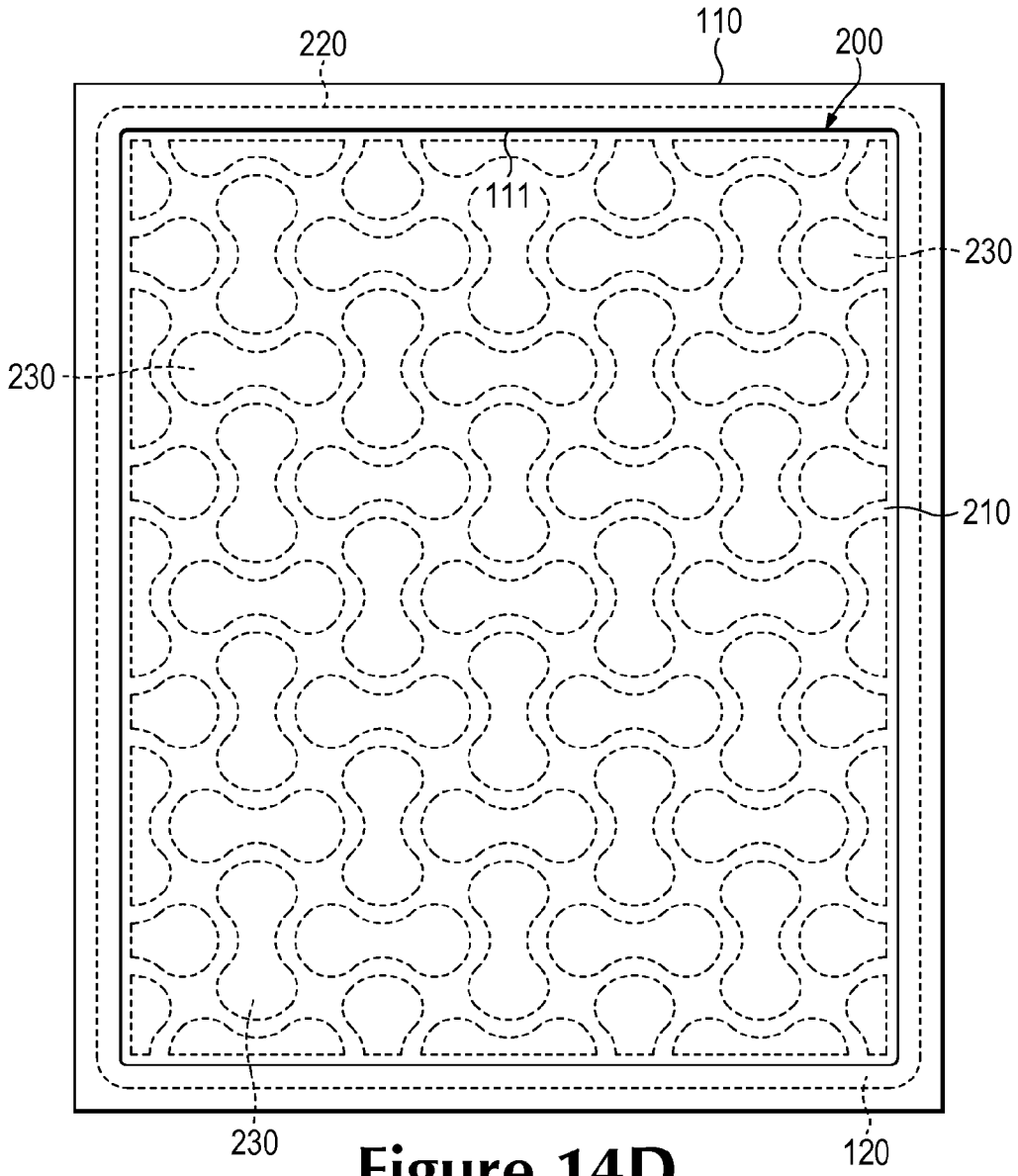

Figure 14D

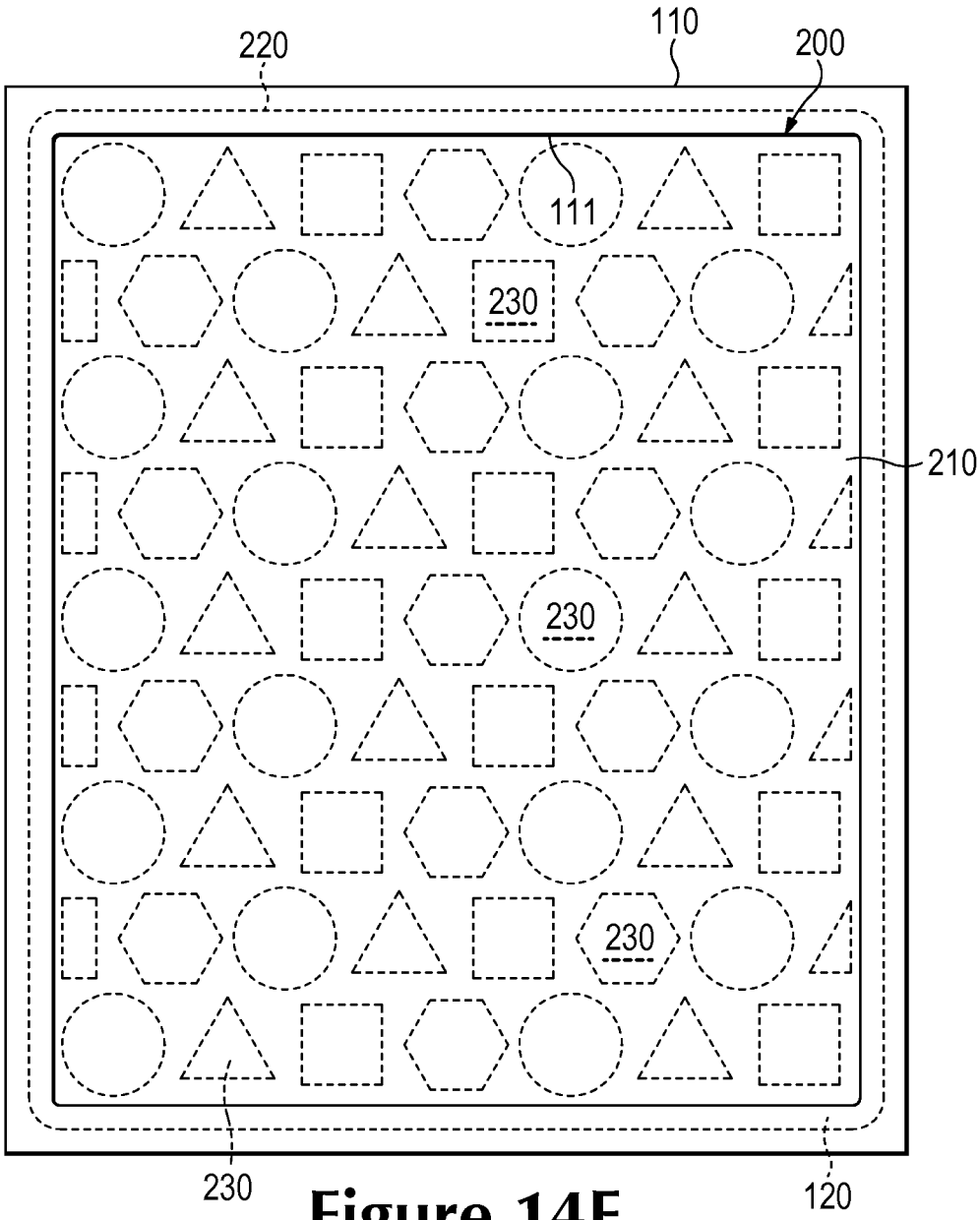

Figure 14E

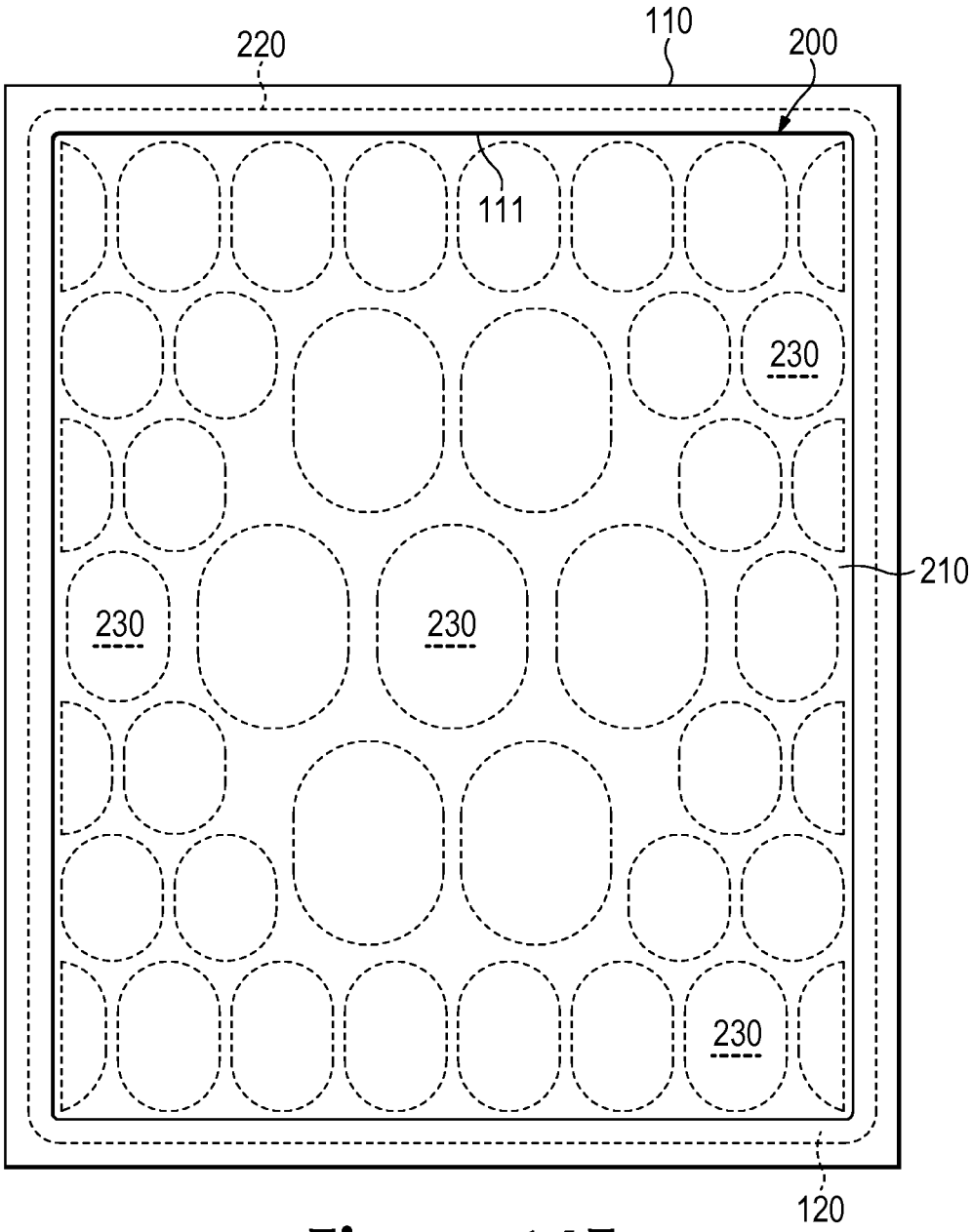

Figure 14F

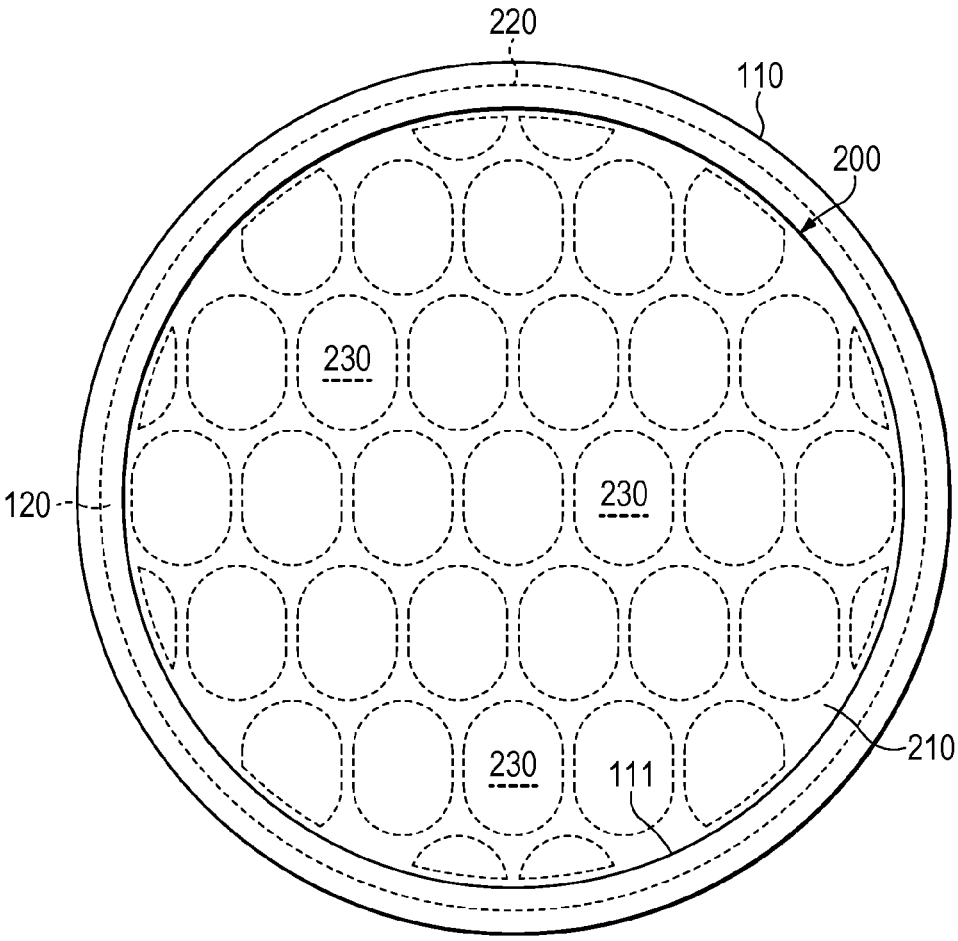

Figure 14G

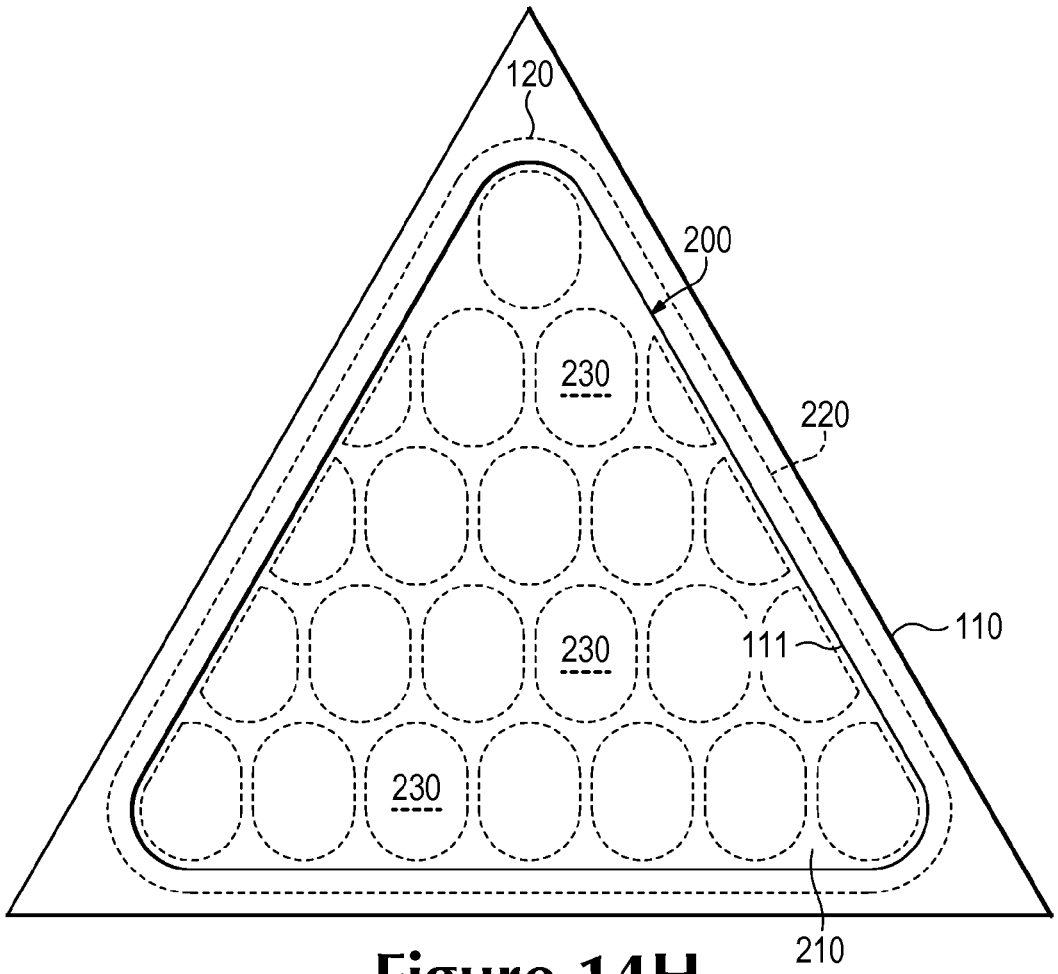

Figure 14H

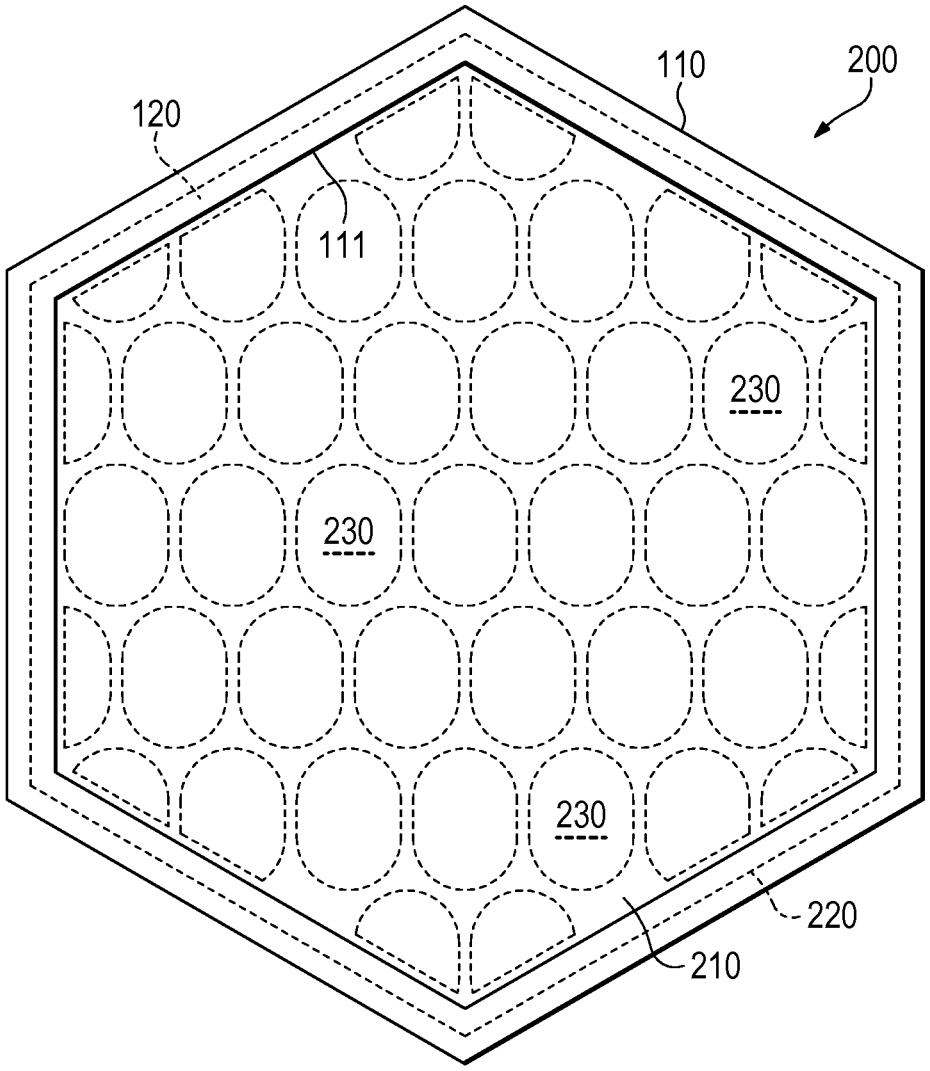

Figure 14I

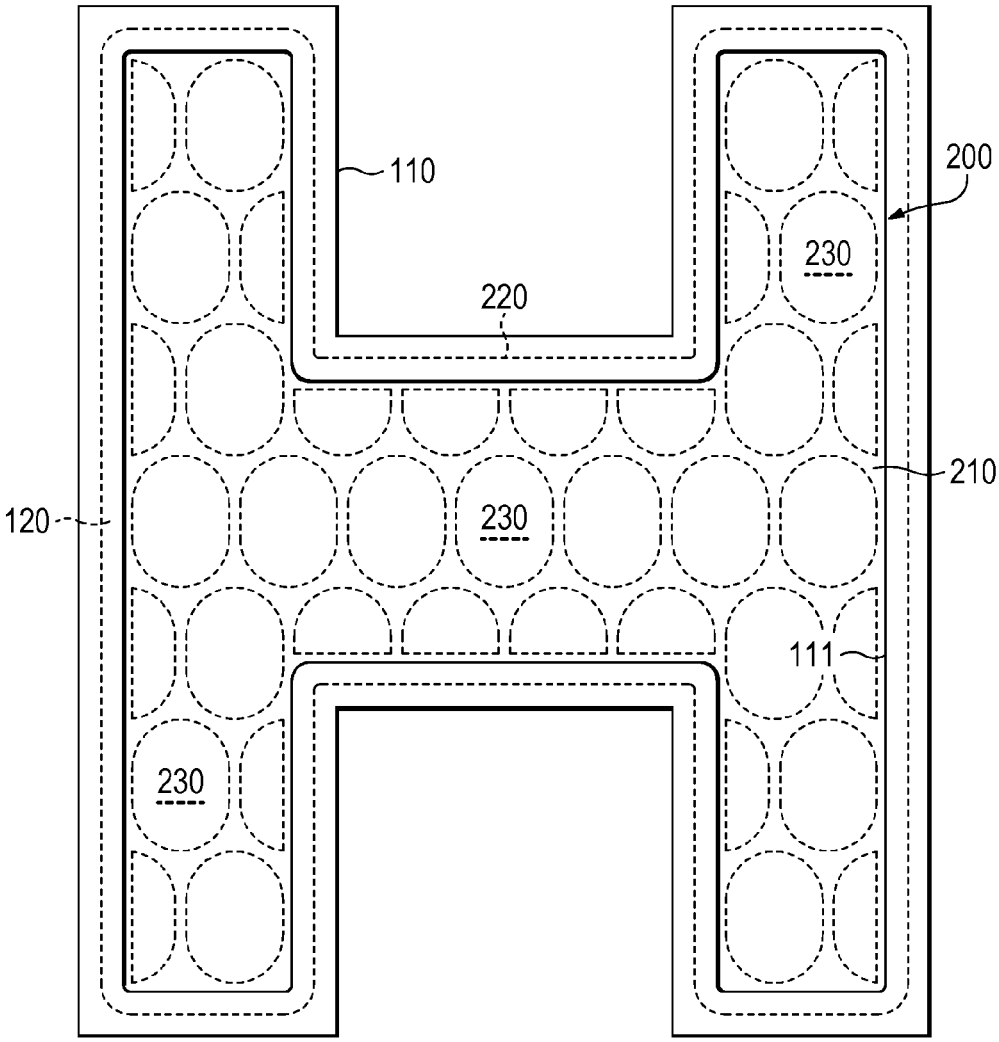

Figure 14J

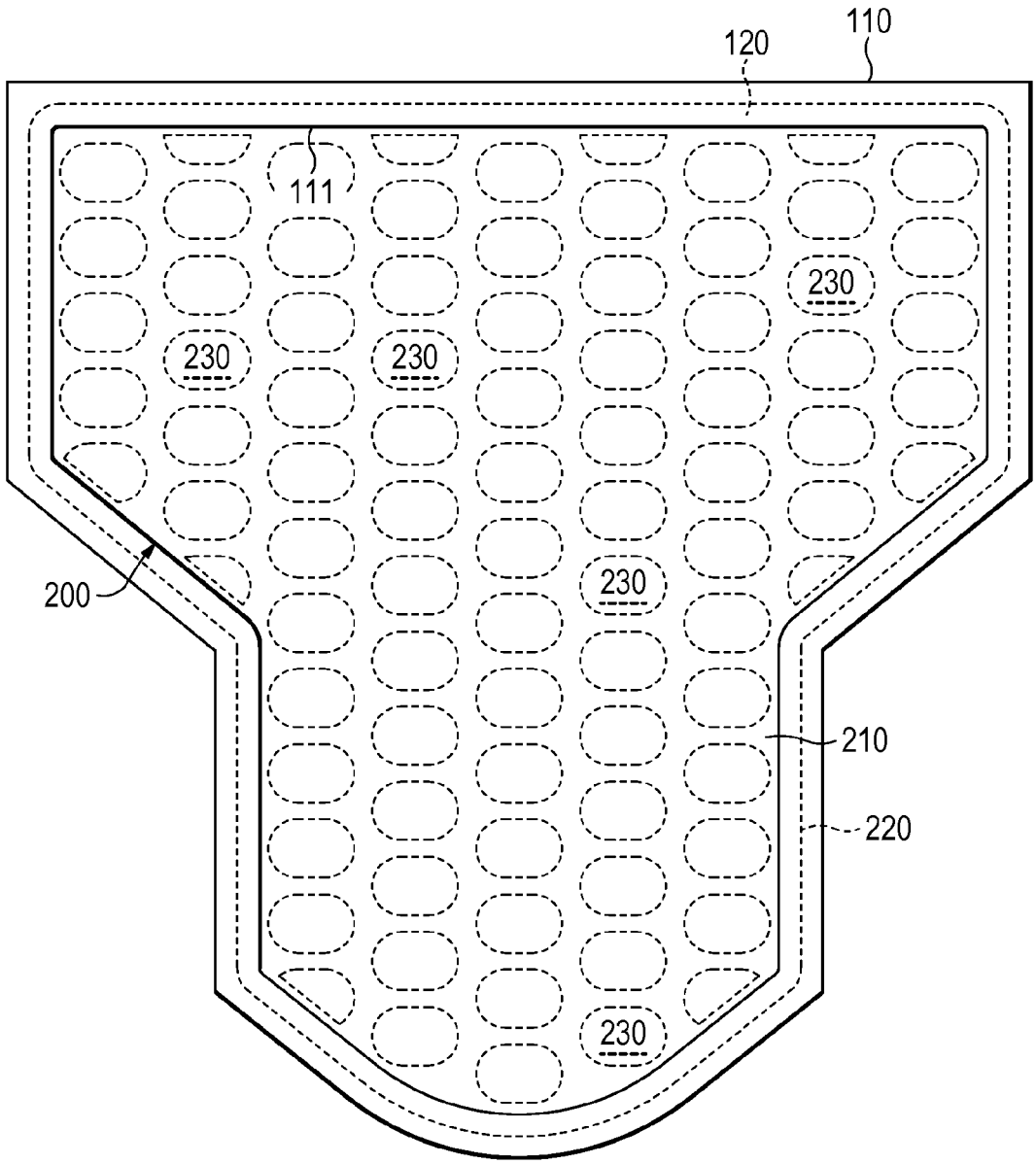

Figure 14K

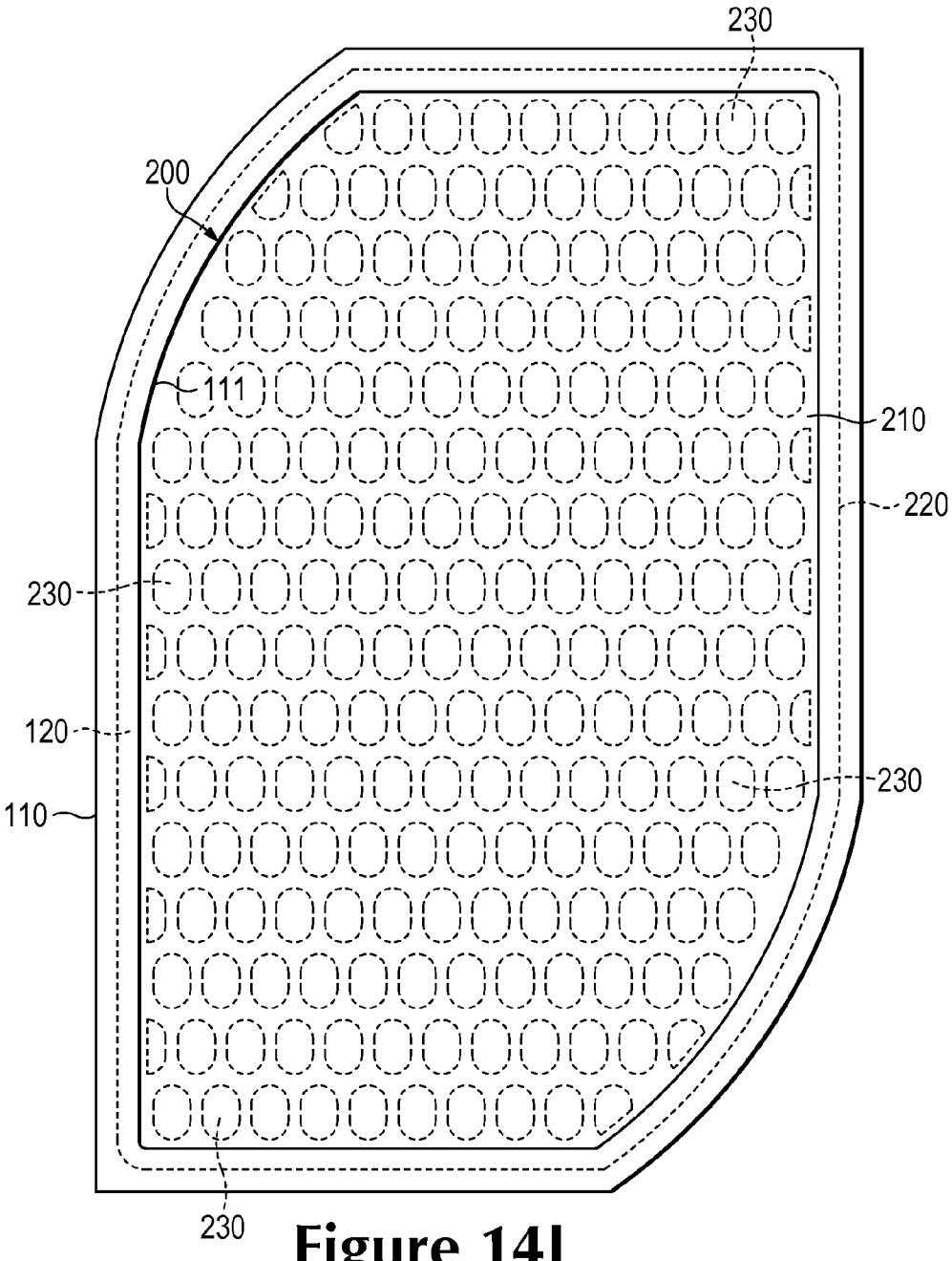

Figure 14L

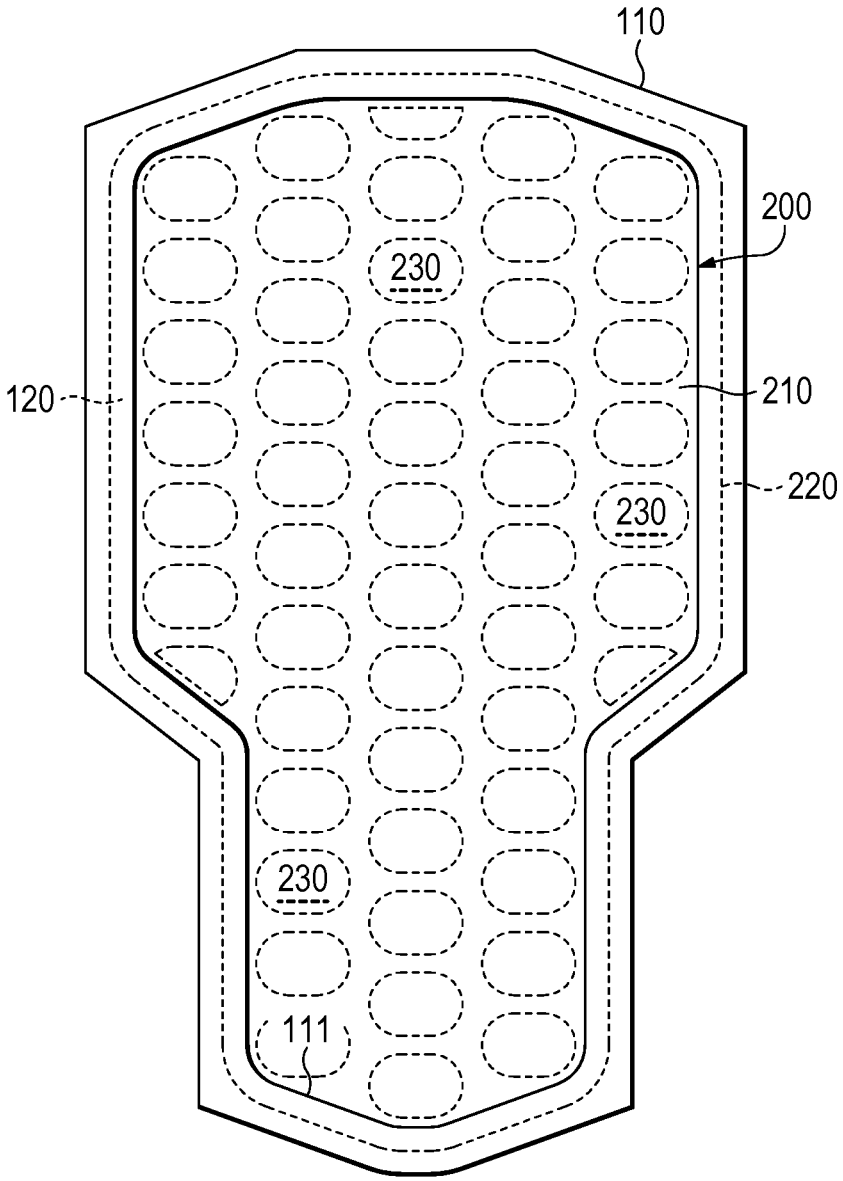

Figure 14M

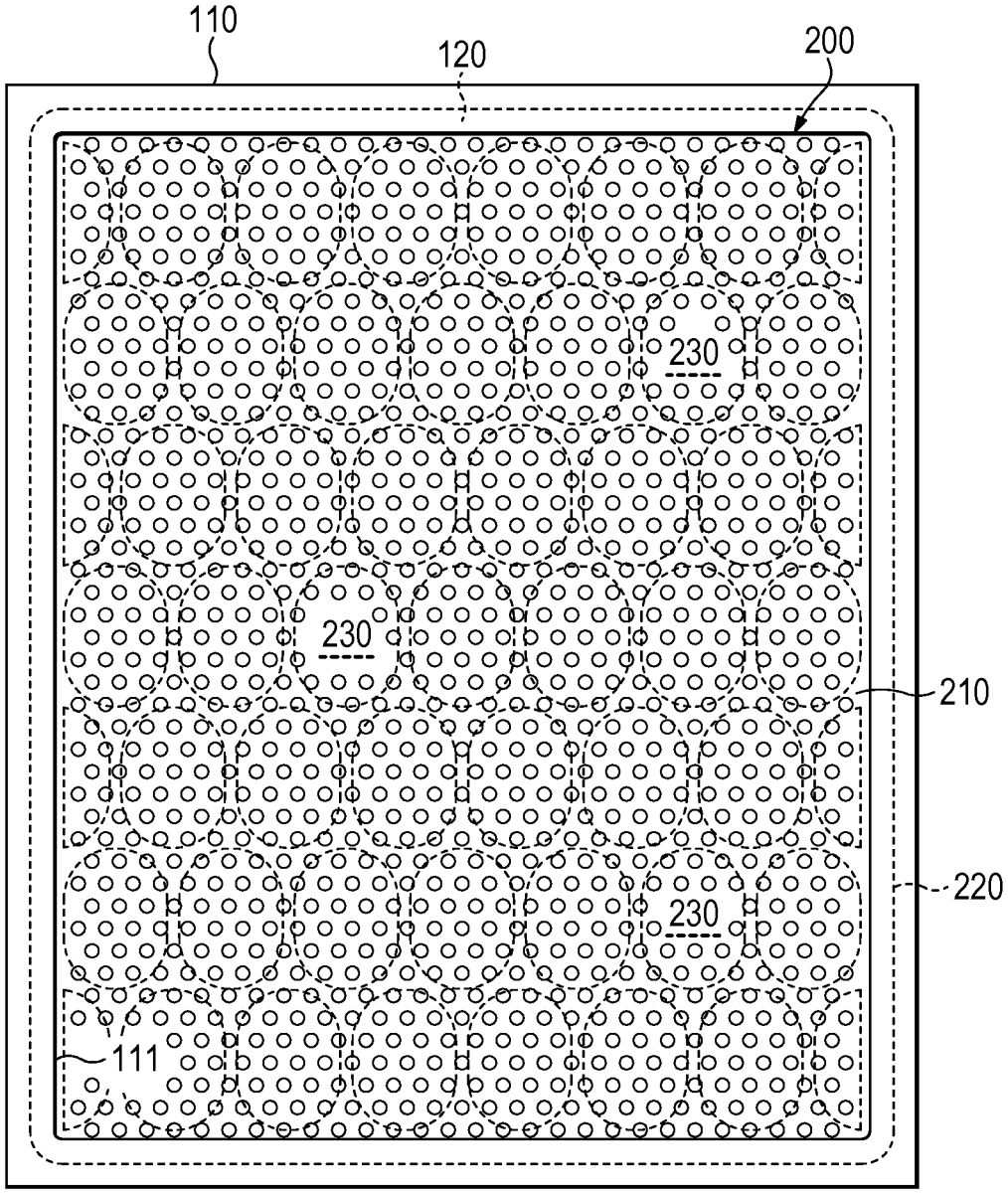

Figure 14N

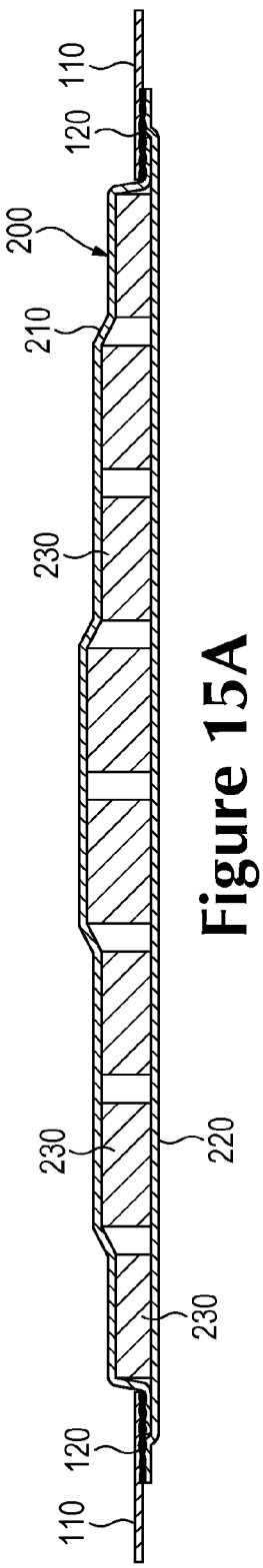

Figure 15A

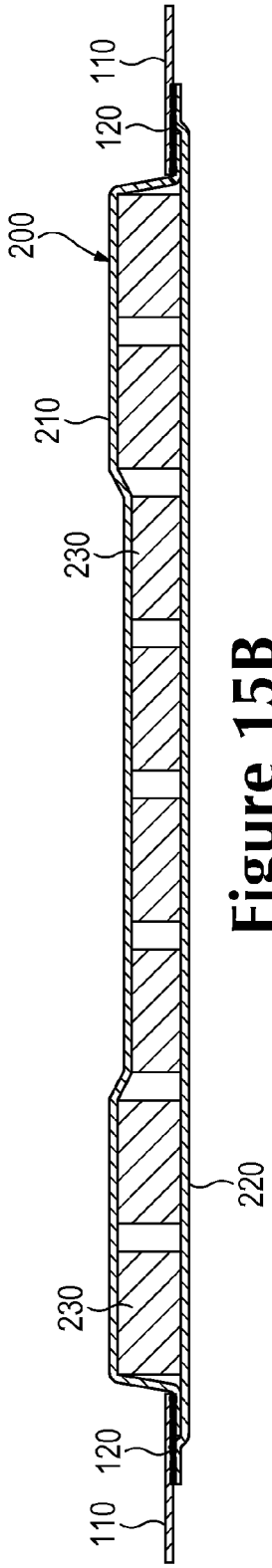

Figure 15B

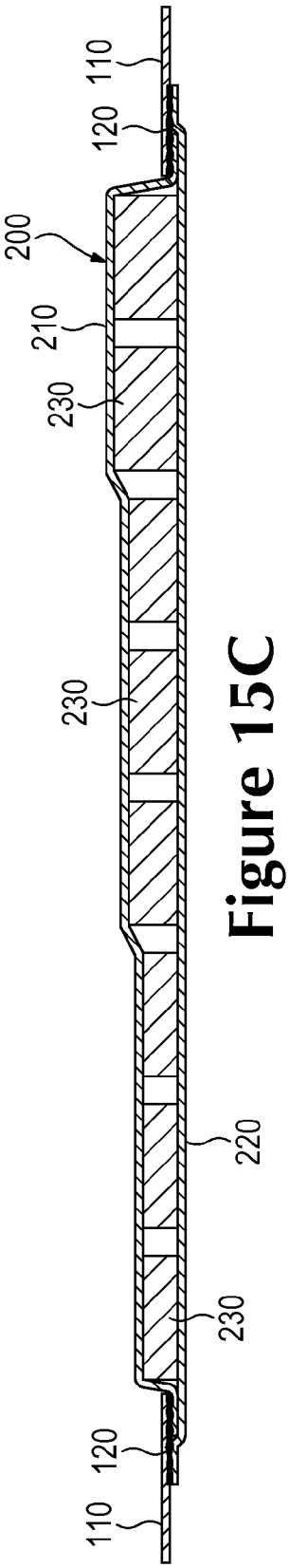

Figure 15C

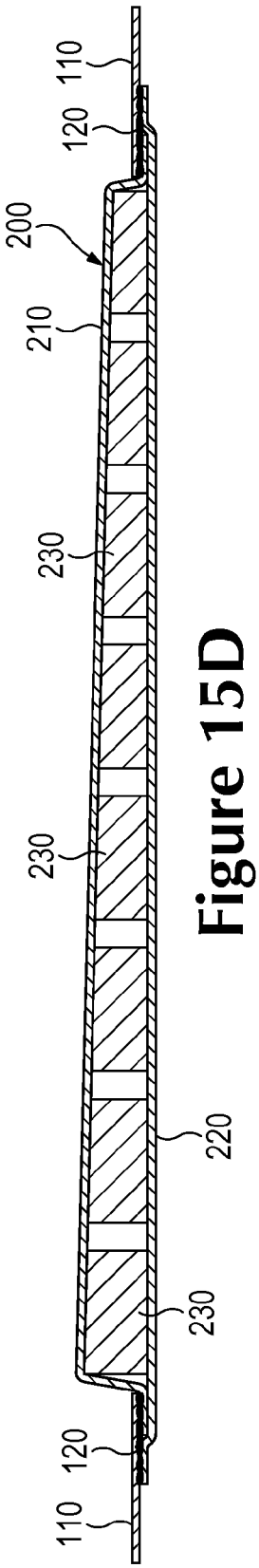

Figure 15D

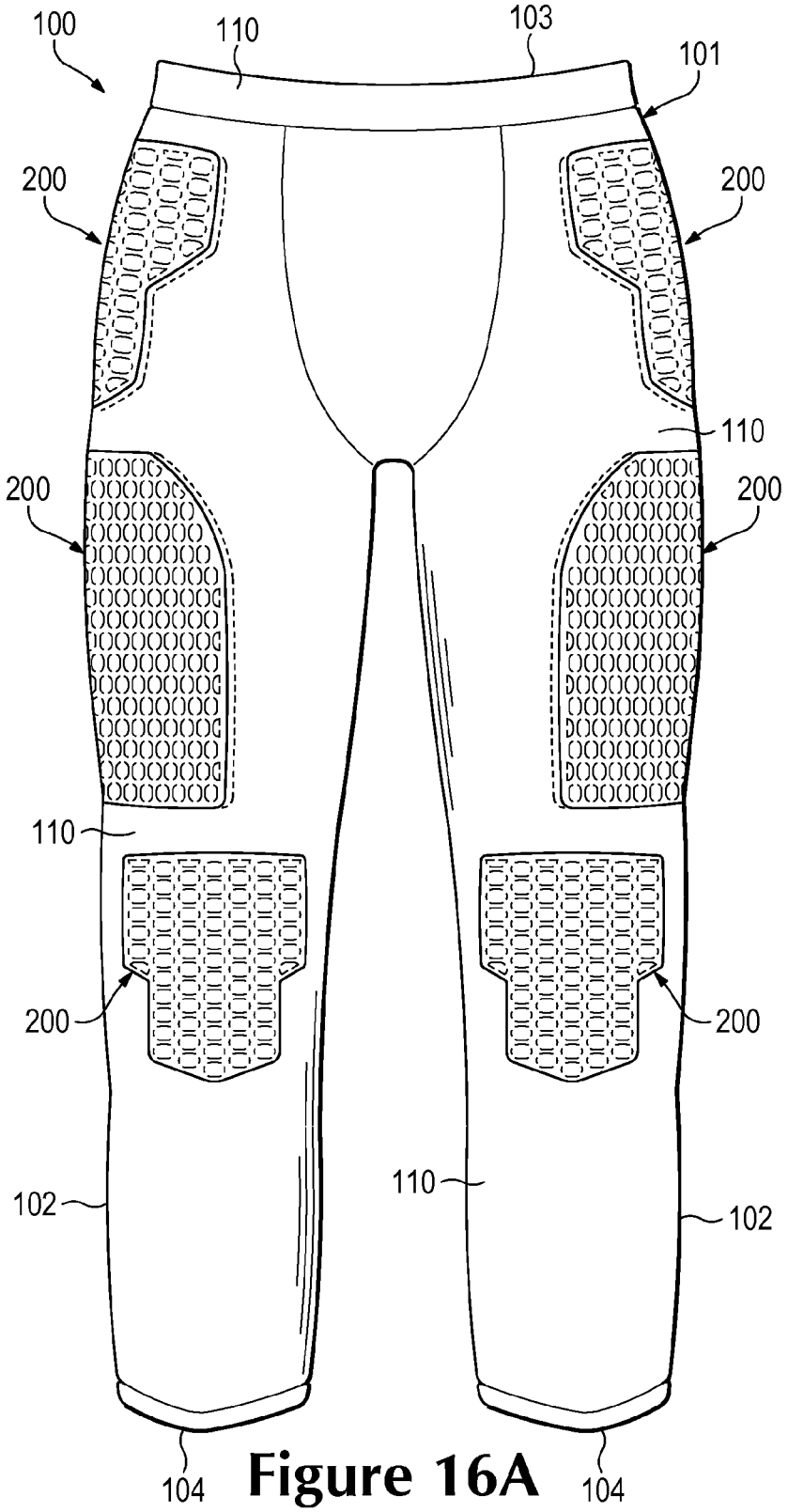
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Figure 16A

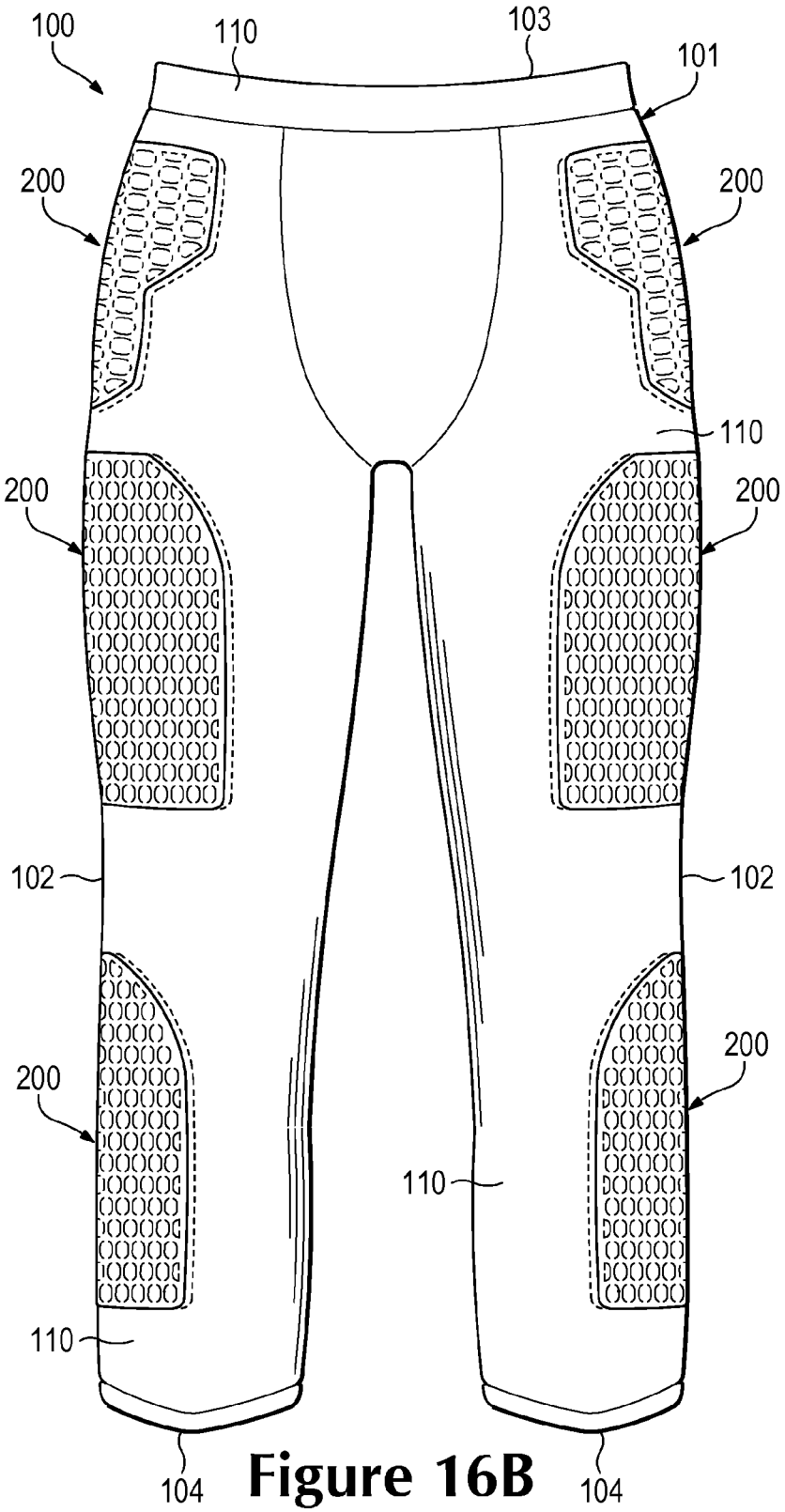
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Figure 16B

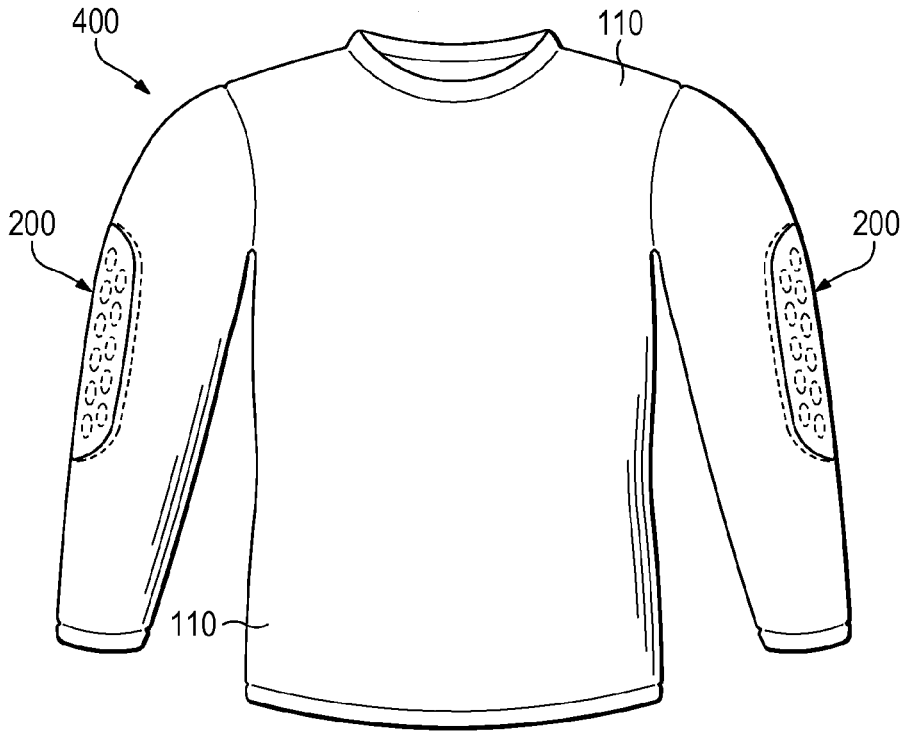

Figure 16C

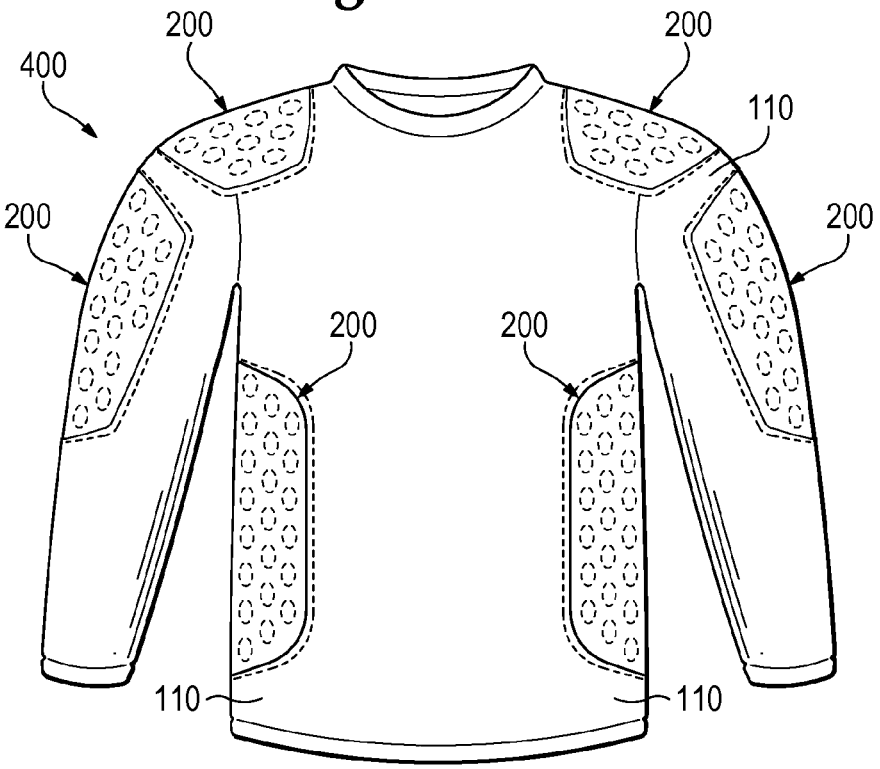

Figure 16D

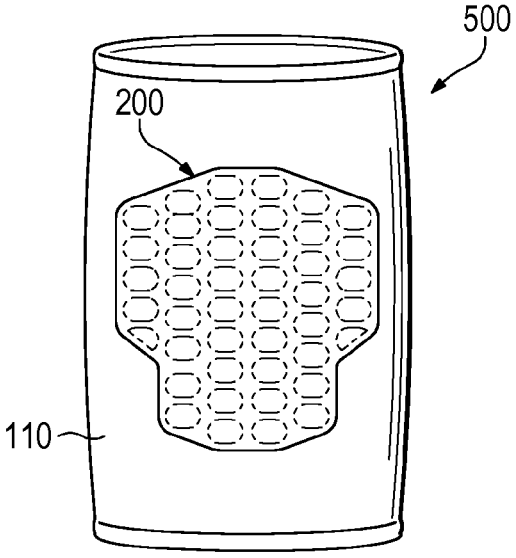

Figure 16E

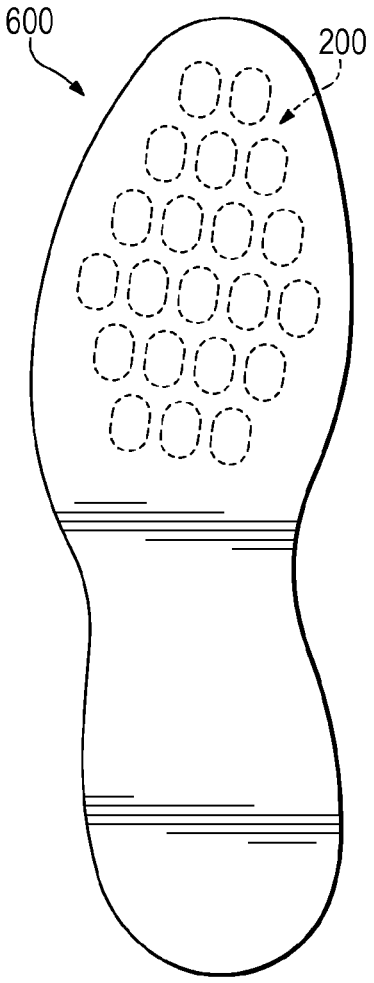

Figure 16F

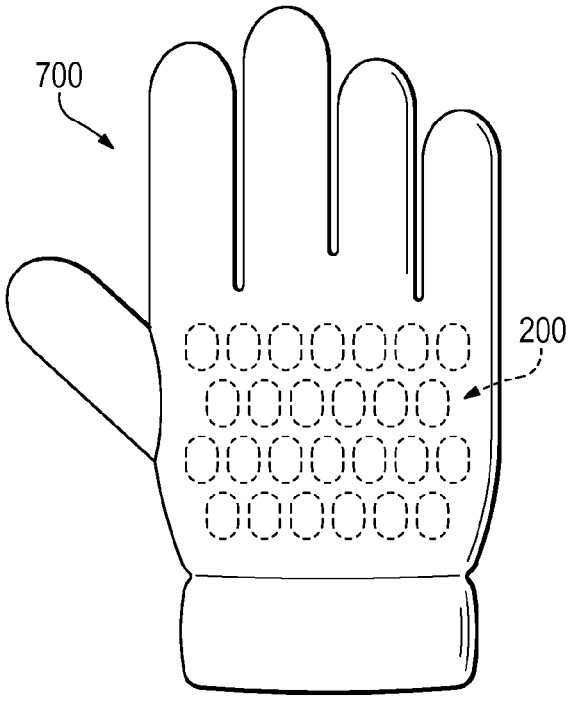

Figure 16G

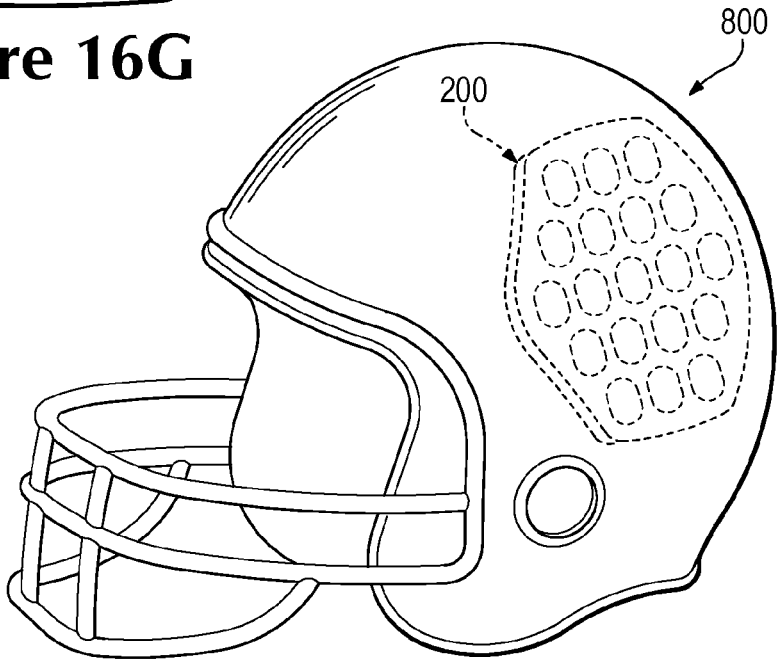

Figure 16H

ARTICLES OF APPAREL INCORPORATING CUSHIONING ELEMENTS AND METHODS OF MANUFACTURING THE ARTICLES OF APPAREL

CROSS-REFERENCE TO RELATED APPLICATION

This application is a divisional of allowed U.S. application Ser. No. 13/035,592, entitled "Articles of Apparel Incorporating Cushioning Elements and Methods of Manufacturing the Articles of Apparel", filed on Feb. 25, 2011, which is now U.S. Pat. No. 8,561,214. This patent application is hereby incorporated by reference in its entirety.

BACKGROUND

Materials or elements that impart padding, cushioning, or otherwise attenuate impact forces are commonly incorporated into a variety of products. Athletic apparel, for example, often incorporates cushioning elements that protect the wearer from contact with other athletes, equipment, or the ground. More specifically, pads used in American football and hockey incorporate cushioning elements that provide impact protection to various parts of a wearer. Helmets utilized during American football, hockey, bicycling, skiing, snowboarding, and skateboarding incorporate cushioning elements that provide head protection during falls or crashes. Similarly, gloves utilized in soccer (e.g., by goalies) and hockey incorporate cushioning elements that provide protection to the hands of a wearer. In addition to apparel, mats (e.g., for yoga or camping), chair cushions, and backpacks, for example, all incorporate cushioning elements to enhance comfort.

SUMMARY

Various articles of apparel that incorporate cushioning elements are disclosed below. In general, the apparel may include a base layer having a first surface and an opposite second surface. The base layer defines an aperture extending through the base layer and from the first surface to the second surface. The cushioning elements may have a first material layer, a second material layer, and a plurality of foam components. The first material layer and the second material layer are bonded to the second surface of the base layer. The foam components are located between and secured to the first material layer and the second material layer. In addition, the foam components are positioned to correspond with a location of the aperture. In some configurations, a bonding element may be utilized to bond the first material layer and the second material layer to the base layer.

Methods for manufacturing the articles of apparel are also disclosed below. In one example, a method includes bonding a thermoplastic polymer element to a base layer. An aperture is formed through the thermoplastic polymer element and the base layer. A plurality of foam components are secured between a first material layer and a second material layer. Additionally, the first material layer and the second material layer are bonded to the thermoplastic polymer element to join the base layer with the first material layer and the second material layer.

The advantages and features of novelty characterizing aspects of the invention are pointed out with particularity in the appended claims. To gain an improved understanding of the advantages and features of novelty, however, reference may be made to the following descriptive matter and accompanying figures that describe and illustrate various configurations and concepts related to the invention.

FIGURE DESCRIPTIONS

The foregoing Summary and the following Detailed Description will be better understood when read in conjunction with the accompanying figures.

FIG. **1** is a front elevational view of an individual wearing an article of apparel.

FIG. **2** is a front elevational view of the article of apparel.

FIGS. **3** and **4** are side elevational views of the article of apparel.

FIG. **5** is a rear elevational view of the article of apparel.

FIG. **6** is a perspective view of a portion of the apparel including a cushioning element.

FIGS. **7**A and **7**B are an exploded perspective views of the portion of the apparel.

FIG. **8** is a top plan view of the portion of the apparel.

FIGS. **9**A and **9**B are cross-sectional views of the portion of the apparel, as defined by section lines **9**A and **9**B in FIG. **8**.

FIG. **9**C is a cross-sectional view corresponding with FIG. **9**A and depicting another configuration of the portion of the apparel.

FIG. **10** is a perspective view of portions of a manufacturing apparatus utilized in a manufacturing process for the portion of the apparel.

FIGS. **11**A-**11**N are schematic perspective views of the manufacturing process.

FIGS. **12**A-**12**N are schematic cross-sectional views of the manufacturing process, as respectively defined by section lines **12**A-**12**N in FIGS. **11**A-**11**N.

FIG. **13** is an exploded perspective views corresponding with FIG. **7**B and depicting a further configuration of the portion of the apparel.

FIGS. **14**A-**14**N are top plan views corresponding with FIG. **8** and depicting further configurations of the portion of the apparel.

FIGS. **15**A-**15**D are cross-sectional views corresponding with FIG. **9**A and depicting further configurations of the portion of the apparel.

FIGS. **16**A-**16**H are elevational views of additional articles of apparel incorporating the cushioning element.

DETAILED DESCRIPTION

The following discussion and accompanying figures disclose various articles of apparel (e.g., shorts, pants, shirts, wraps, gloves, helmets, and footwear) that incorporate cushioning elements. Additionally, the following discussion and accompanying figures disclose various processes associated with manufacturing the apparel and cushioning elements.

Apparel Configuration

With reference to FIG. **1**, an individual **10** is depicted as wearing an article of apparel **100** with the general configuration of a shorts-type garment. Although apparel **100** may be worn under other articles of apparel, apparel **100** may be worn alone, may be exposed, or may be worn over other articles of apparel. Apparel **100** may also be worn in combination with other pieces of equipment (e.g., athletic or protective equipment). Accordingly, the configuration of apparel **100** and the manner in which apparel **100** is worn by individual **10** may vary significantly.

Apparel **100** is depicted individually in FIGS. **2**-**5** as including a pelvic region **101** and a pair of leg regions **102** that extend outward from pelvic region **101**. Pelvic region **101** corresponds with a pelvic area of individual **10** and covers at

least a portion of the pelvic area when worn. An upper area of pelvic region **101** defines a waist opening **103** that extends around a waist of individual **10** when apparel **100** is worn. Leg regions **102** correspond with a right leg and a left leg of individual **10** and cover at least a portion of the right leg and the left leg when worn. Lower areas of leg regions **102** each define a thigh opening **104** that extends around a thigh of individual **10** when apparel **100** is worn.

The primary elements forming apparel **100** are a base layer **110** and a plurality of cushioning elements **200**. Base layer **110** extends throughout apparel **100** and forms areas of pelvic region **101** and both of leg regions **102**, as well as defining waist opening **103** and thigh opening **104**. Although base layer **110** may be a single element of textile or other material, base layer **110** may also be a plurality of joined elements. Additionally, base layer **110** defines an exterior surface **105** that faces away from individual **10** when apparel **100** is worn, and base layer **110** defines an opposite interior surface **106** that faces toward individual **10** and may contact individual **10** when apparel **100** is worn.

Cushioning elements **200** are incorporated into various areas of apparel **100** to impart padding, cushioning, or otherwise attenuate impact forces. When apparel **100** is worn during athletic activities, for example, cushioning elements **200** may protect individual **10** from contact with other athletes, equipment, or the ground. With regard to apparel **100**, cushioning elements **200** are located in both of pelvic region **101** and leg regions **102** and are positioned, more specifically, to protect the hips, thighs, and tailbone of individual **10**. As described in greater detail below, cushioning elements **200** may be incorporated into a variety of different articles of apparel, and cushioning elements **200** may be positioned in various areas of the articles of apparel to protect specific portions (e.g., muscles, bones, joints, impact areas) of individual **10**. Additionally, the shapes, sizes, and other properties of cushioning elements **200**, as well as the materials and components utilized in cushioning elements **200**, may vary significantly to provide a particular level of protection to the specific portions of individual **10**. Although cushioning elements **200** may be located within apparel **100** and not visible, cushioning elements **200** are depicted as forming portions of an exterior and an interior of apparel **100**.

Cushioning Element Configuration

A portion of apparel **100** that includes one of cushioning elements **200** is depicted in FIGS. **6-9**B. Base layer **110** defines an aperture **111** that extends from exterior surface **105** to interior surface **106**, thereby extending through base layer **110**. Cushioning element **200** is located proximal to aperture **111** and is secured to base layer **110**. More particularly, cushioning element **200** is secured to interior surface **106** with a bonding element **120** and is exposed through aperture **111**.

Cushioning element **200** includes a first material layer **210**, a second material layer **220**, and a plurality of pad components **230** that are secured to each of material layers **210** and **220**. First material layer **210** and second material layer **220** cooperatively form an outer surface or covering for cushioning element **200**. That is, first material layer **210** and second material layer **220** cooperatively form a pocket or void, in which pad components **230** are located. Although cushioning element **200** may be incorporated into apparel **100** in a variety of ways, first material layer **210** is depicted as being exposed through aperture **111**, second material layer **220** is depicted as being located inward from first material layer **210**, and pad components **230** are depicted as being positioned to correspond with the location of aperture **111**.

Both of material layers **210** and **220** are secured to the portion of base layer **110** forming interior surface **106** with bonding element **120**. Referring to FIGS. **9**A and **9**B, first material layer **210** is secured to a portion of bonding element **120** that is adjacent to aperture **111** and second material layer **220** is secured to a portion of bonding element **120** that is spaced from aperture **111**. In this configuration, the area of second material layer **220** may be greater than the area of first material layer **210**. That is, second material layer **220** is secured to a more outward portion of base layer **110** (i.e., the portion that is spaced from aperture **111**) than first material layer **210** and may have greater area.

A variety of materials may be utilized for first material layer **210** and second material layer **220**, including various textiles, polymer sheets, leather, or synthetic leather, for example. Combinations of these materials (e.g., a polymer sheet bonded to a textile) may also be utilized for material layers **210** and **220**. Although material layers **210** and **220** may be formed from the same material, each of material layers **210** and **220** may also be formed from different materials. With regard to textiles, material layers **210** and **220** may be formed from knitted, woven, non-woven, spacer, or mesh textile components that include rayon, nylon, polyester, polyacrylic, elastane, cotton, wool, or silk, for example. Moreover, the textiles may be non-stretch, may exhibit one-directional stretch, or may exhibit multi-directional stretch. Accordingly, a variety of materials are suitable for material layers **210** and **220**.

Pad components **230** are located between and secured (e.g., bonded) to each of material layers **210** and **220**. In addition, pad components **230** are positioned to correspond with the location of aperture **111**. That is, pad components **230** are generally positioned adjacent to aperture **111** and may be positioned such that aperture **111** effectively extends around pad components **230**. Although the shapes of pad components **230** may vary significantly, the surfaces that are secured material layers **210** and **220** are depicted as having an elliptical or generally elongate shape with rounded end areas, and side surface of pad components **230** extend in a generally straight fashion between material layers **210** and **220**. Pad components **230** are also depicted as being spaced evenly from each other and arranged in rows, particularly offset rows, but may be spaced or located in a variety of arrangements. An advantage of arranging pad components **230** in offset rows is that the area between pad components **230** is effectively minimized, while retaining a regular spacing between adjacent pad components **230**.

A variety of materials may be utilized for pad components **230**, including various polymer foam materials that return to an original shape after being compressed. When formed from polymer foam materials, pad components **230** may have the form of foam components. Examples of suitable polymer foam materials that are suitable for pad components **230** include polyurethane, ethylvinylacetate, polyester, polypropylene, and polyethylene foams. Moreover, both thermoplastic and thermoset polymer foam materials may be utilized. In some configurations of cushioning element **200**, pad components **230** may be formed from a polymer foam material with a varying density, or solid polymer or rubber materials may be utilized. Fluid-filled chambers may also be utilized as pad components **230**. Also, different pad components **230** may be formed from different materials, or may be formed from similar materials with different densities. As discussed in greater detail below, the polymer foam materials forming pad components **230** attenuate impact forces to provide cushioning or protection. By selecting thicknesses, materials, and densities for each of the various pad components **230**, the

degree of impact force attenuation may be varied throughout cushioning element **200** to impart a desired degree of cushioning or protection.

The compressible polymer foam materials forming pad components **230** attenuate impact forces that compress or otherwise contact cushioning element **200**. When incorporated into apparel **100** or another article of apparel, for example, the polymer foam materials of pad components **230** may compress to protect a wearer from contact with other athletes, equipment, or the ground. Accordingly, cushioning element **200** may be utilized to provide cushioning or protection to areas of individual **10** or other wearers that are covered by cushioning element **200**.

Bonding element **120** joins material layers **210** and **220** to base layer **110** around aperture **111**. Referring to FIGS. **7**A and **7**B, for example, bonding element **120** is located at an edge of aperture **111** and extends entirely around aperture **111**. A variety of materials may be utilized for bonding element **120**, including thermoplastic polymer materials (e.g., polyurethane), various adhesives, or heat-activated adhesives, for example. When formed from a thermoplastic polymer material, for example, the application of heat and pressure may be utilized to bond material layers **210** and **220** to interior surface **106** with bonding element **120**. A thermoplastic polymer material melts when heated and returns to a solid state when cooled sufficiently. Based upon this property of thermoplastic polymer materials, thermalbonding processes may be utilized to form a thermalbond that joins material layers **210** and **220** to base layer **110**. As utilized herein, the term "thermalbonding" or variants thereof is defined as a securing technique between two elements that involves a softening or melting of a thermoplastic polymer material within at least one of the elements such that the materials of the elements are secured to each other when cooled. Similarly, the term "thermalbond" or variants thereof is defined as the bond, link, or structure that joins two elements through a process that involves a softening or melting of a thermoplastic polymer material within at least one of the elements such that the materials of the elements are secured to each other when cooled. With regard to bonding element **120**, thermalbonding may involve, for example, the melting or softening of thermoplastic materials within bonding element **120** to join material layers **210** and **220** to base layer **110**. Additionally, thermalbonding does not generally involve the use of stitching or adhesives, but involves directly bonding elements to each other with heat. In some situations, however, stitching or adhesives may be utilized to supplement the thermalbond or the joining of elements through thermalbonding. As an alternative to thermalbonding, an adhesive, a thermally-activated adhesive, stitching, or other securing structure may be utilized to join each of material layers **210** and **220** to interior surface **106**.

In addition to attenuating impact forces, cushioning element **200** has an advantage of simultaneously providing one or more of breathability, flexibility, a relatively low overall mass, and launderability. When incorporated into an article of apparel, such as apparel **100**, a wearer may perspire and generate excess heat. By utilizing a permeable textile for material layers **210** and **220** and also forming gaps between adjacent pad components **230**, areas for air to enter apparel **100** and for moisture to exit apparel **100** are formed through cushioning element **200**. More particularly, air and moisture may pass through material layers **210** and **220** and between pad components **230** to impart breathability to areas of apparel **100** having cushioning element **200**. Moreover, the materials and structure discussed above for cushioning element **200** impart flexibility and a low overall mass to cushioning element **200**. Furthermore, the materials and structure discussed above for cushioning element **200** permits cushioning element **200** to be laundered without significant shrinkage or warping, even when temperatures associated with commercial laundering processes are utilized. Accordingly, cushioning element **200** may simultaneously provide impact force attenuation, breathability, flexibility, a relatively low overall mass, and launderability to an article of apparel.

The position of cushioning element **200** with respect to aperture **111** and surfaces **105** and **106** may vary depending upon whether apparel **100** is being worn by individual **10**. Referring to FIG. **7**A, base layer **110** and cushioning element **200** are depicted as being in a neutral state, which may occur when apparel **100** is not being worn and no significant forces are exerted upon apparel **100**. In this state, first material layer **210** extends across aperture **111** and pad components **230** are located below aperture **111**. Referring to FIG. **7**C, however, a force **107** is acting upon cushioning element **200**, and may also be acting upon base layer **110**. That is, force **107** presses upward on second material layer **220** and portions of interior surface **106**. Force **107** may, for example, be similar to a force that the body of individual **10** exerts upon apparel **100**. In this state, first material layer **210** and pad components **230** protrude through aperture **111** due to the presence of force **107**. Note that FIG. **1** depicts a configuration where cushioning elements **200** protrude outward due to the presence of individual **10**, whereas FIGS. **2**-**5** depict a configuration wherein cushioning elements **200** are recessed within apparel **100** due to the absence of individual **10**.

Manufacturing Process

A variety of techniques may be utilized to manufacture apparel **100** to include cushioning element **200**. With reference to FIG. **10**, a manufacturing apparatus **300** is disclosed as including a die **310**, an extractor **320**, a heating plate **330**, a press plate **340**, a platen **350**, and a cutter **360**. The configurations depicted in FIG. **10** and discussed below for manufacturing apparatus **300** are intended to provide an example of a manufacturing apparatus that may be utilized in the manufacture of apparel **100**. A variety of other manufacturing apparatuses that operate in a similar manner may also be utilized.

Die **310** includes a base **311**, a plurality of die elements **312**, a plurality of ejection members **313**, and a pair of registration pegs **314**. Base **311** is formed from a durable and rigid material, such as steel or aluminum, to provide a foundation for die **310**. Die elements **312** extend outward (e.g., upward) from base **311** and exhibit a general shape of pad components **230**. More particularly, an interior area of each die element **312** has the general shape of an individual pad component **230**. As discussed in greater detail below, edges **315** (e.g., upper edges) of die elements **312** are utilized to cut through a material that forms pad components **230**, thereby shaping and forming each of pad components **230**. Edges **315** may generally have a sharpened configuration that assists with cutting through the material that forms pad components **230**. Ejection members **313** are located within the interior areas of each die element **312** and are spaced (e.g., spaced downward) from edges **315**. As an example, ejection members **313** may be formed from a polymer foam material with lesser compressibility than a polymer foam material forming pad components **230**. Additionally, registration pegs **314** extend outward (e.g., upward) from base **311**.

In addition to having the general shape of pad components **230**, die elements **312** are arranged or otherwise located relative to each other in the same manner as pad components **230**. As noted above, pad components **230** are depicted as being spaced evenly from each other and arranged in offset rows.

Similarly, die elements **312** are spaced evenly from each other and arranged in offset rows. That is, die elements **312** are arranged in a configuration that corresponds with the positions of pad components **230** in cushioning element **200**. If, however, a different arrangement is desired for pad components **230**, then die elements **312** may be moved or otherwise repositioned to correspond with the different arrangement.

Extractor **320** includes a base **321**, a plurality of extractor elements **322**, a pair of registration apertures **323**, and an extractor sheet **324**. Base **321** is formed from a durable and rigid material, such as steel or aluminum, to provide a foundation for extractor **320**. Extractor elements **322** have the configurations of pins that extend outward (e.g., downward) from base **321** and have sharpened or pointed end areas. As discussed in greater detail below, extractor elements **322** assist with retaining the positions of pad components **230** upon removal from die **310**. As an alternative to pins, extractor elements **322** (a) may have the configurations of needles, nails, spikes, or prongs or (b) may be a vacuum system that retains the positions of pad components **230** upon removal from die **310**, for example Accordingly, extractor elements **322** are any device or system that may be used to secure pad components **230** to extractor **320** and assist with retaining the positions of pad components **230** upon removal from die **310**. Additionally, registration apertures **323** form holes in base **321** that are positioned to correspond with and receive registration pegs **314**.

The positions of extractor elements **322** correspond with the locations of die elements **312**. Moreover, extractor elements **322** are arranged or otherwise located relative to each other in the same manner as die elements **312**, and die elements **313** are arranged or otherwise located relative to each other in the same manner as pad components **230**. That is, extractor elements **322** are arranged in a configuration that corresponds with the positions of pad components **230** in cushioning element **200**. If, however, a different arrangement is desired for pad components **230**, then extractor elements **322** and die elements **312** may be moved or otherwise repositioned to correspond with the different arrangement.

Extractor sheet **324** lays adjacent to base **321** and includes a plurality of apertures that receive extractor elements **322**. That is, extractor elements **322** extend through the apertures in extractor sheet **324**. A variety of materials may be utilized for extractor sheet **324**, including various polymer materials and metals.

Heating plate **330** includes a base **331** that may also be formed from a durable and rigid material, such as steel or aluminum, and incorporates heating elements. More particularly, electric coils may extend through base **331** to heat base **331** to temperatures that bond (a) pad components **230** to material layers **210** and **220** and (b) material layers **210** and **220** to base layer **110** with bonding element **120**. As an alternative, base **331** may incorporate fluid channels through which a heated fluid passes, or radiant heaters, radio frequency emitters, or other devices may be utilized. In some configurations of heating plate **330**, a surface of base **331** that contacts portions of cushioning element **200** during the manufacturing process may incorporate a rubber or silicone material.

Press plate **340** includes a base **341**, a first compressible element **342**, and a second compressible element **343**. As with bases **311**, **321**, and **331**, base **341** may be formed from a durable and rigid material, such as steel or aluminum. Compressible elements **342** and **343** are recessed within a surface of base **341** such that second compressible element **343** surrounds or otherwise extends around first compressible element **342**. First compressible element **342** has a shape that forms a general outline of the area of cushioning element **200** that includes pad components **230**, and second compressible element **343** has a shape that forms a general outline of bonding element **120**. Compressible elements **342** and **343** are formed from materials (e.g., silicone, polymer foam) that compress or deform when a force is applied and return to an original shape when the force is removed. Although both of compressible elements **342** and **343** compress, the degree of compression may be different. That is, first compressible element **342** may compress to a greater degree than second compressible element **343**.

Platen **350** is generally formed from a non-compressible material and includes a surface **351** against which elements may be pressed. Although platen **350** is depicted as being a individual element, platen **350** may be a workbench surface, a surface within an existing heat press that includes heating plate **350**, or any other suitable surface. Cutter **360** is a laser cutting apparatus, such as any conventional CO_2 or Nd:YAG laser apparatuses. As an alternative to a laser cutting apparatus, cutter **360** may be a die cutting apparatus, punch press, or pair of scissors.

With reference to FIGS. **11**A-**11**M and **12**A-**12**M, an example of a suitable manufacturing process utilizing manufacturing apparatus **300** is disclosed. As an initial portion of the manufacturing process, base layer **110** is formed to define aperture **111** and include bonding element **120**. Referring to FIGS. **11**A and **12**A, base layer **110** and bonding element **120** are located between heating plate **330** and platen **350**. Base layer **110** and bonding element **120** are then compressed to effectively bond or otherwise secure bonding element **120** to base layer **110**, as depicted in FIGS. **11**B and **12**B. As discussed above, base **331** of heating plate **330** incorporates heating elements. As such, the temperature of base **331** may be elevated to a point where bonding occurs between base layer **110** and bonding element **120**. The combination of base layer **110** and bonding element **120** is then incised or otherwise cut with cutter **360** to form aperture **111**, as depicted in FIGS. **11**C and **12**C. That is, a laser from cutter **360** incises and passes through both base layer **110** and bonding element **120** to form aperture **111**. From this portion of the manufacturing process, bonding element **120** is located at an edge of aperture **111** and extends entirely around aperture **111**, and aperture **111** extends through a central area of bonding element **120**. At this stage of the process, the combination of base layer **110** and bonding element **120** are set aside for future use.

Continuing with the manufacturing process, die elements **312** are arranged in a configuration that corresponds with the positions of pad components **230** in cushioning element **200**, and extractor elements **322** are arranged in a configuration that corresponds with the positions of die elements **312** and pad components **230** in cushioning element **200**. A blank **301** is then placed between die **310** and extractor **320**, as depicted in FIGS. **11**D and **12**D. Blank **301**, from which pad components **230** are cut, is formed from the same material as pad components **230** and has a thickness of pad components **230**. Once blank **301** is positioned, die **310** and extractor **320** close upon, compress, and cut blank **301**, as depicted in FIGS. **11**E and **12**E. More particularly, (a) blank **301** is compressed against die elements **312** such that edges **315** pierce and cut through blank **301** and (b) extractor elements **322** pierce and enter blank **301**. Note that extractor elements **322** are positioned to correspond with each of die elements **312** and enter the interior area of each of die elements **312**, which is where ejection members **313** are located. Depending upon the lengths of extractor elements **322**, end areas of extractor elements **322** may pass through blank **301** and pierce ejection

members **313** during this operation. In order to ensure that die elements **312** properly align with extractor elements **322**, registration pegs **314** are aligned with and enter registration apertures **323**.

At this stage of the process, die elements **312** have effectively cut through blank **301**. Referring to FIG. **12**E, edges **315** of die elements **312** pass entirely through blank **301** to rest against a surface of extractor sheet **324**. As noted above, the interior area of each die element **312** has the general shape of an individual pad component **230**. Accordingly, the individual pad components **230** are located within die elements **312** and are compressed between a surface of extractor sheet **324** and ejection members **313**. As depicted in FIGS. **11**F and **12**F, die **310** and extractor **320** then separate to remove pad components **230** from within die elements **312**, and pad components **230** are secured to extractor **320** by the various extractor elements **322**. Referring again to FIG. **12**E, portions of blank **301** within die elements **312** (i.e., the portions forming pad components **230**) are compressed more than portion of blank **301** that are exterior of die elements **312**. That is, portions of blank **301** within die elements **312** are compressed against ejection members **313**. When die **310** and extractor **320** separate, the compression of pad components **230** causes pad components **230** to expand outward from die elements **312** and remain properly positioned on extractor elements **322**. As a result, pad components **230** remain secured to extractor elements **322** upon the separation of die **310** and extractor **320**. Additionally, note that blank **301** may remain within die **310** (i.e., around the various die elements **312**) at this stage, or may be separated from die **310**, and also that blank **301** defines various apertures where pad components **230** were removed.

Referring to FIG. **12**F, extractor elements **322** extend through and protrude from pad components **230**. An advantage of this configuration is that extractor elements **322** may have a length that is suitable for a variety of thicknesses in pad components **230**. As described in greater detail below, extractor elements **322** may also have a configuration that retracts into base **321**, thereby facilitating future bonding steps or accommodating configurations where pad components **230** have different thicknesses.

As a summary of the manufacturing process up to this point, pad components **230** have effectively been removed from blank **301**. More particularly, (a) die elements **312** were utilized to cut through blank **301** to form pad components **230** and (b) pad components **230** are removed from die elements **312** and remain secured to extractor **320** due to the presence of extractor elements **322**, which extend into the various pad components **230**. Additionally, pad components **230** are positioned and oriented in the same manner as die elements **312** and are, therefore, positioned and oriented as within cushioning element **200**. Accordingly, pad components **230** have been removed from blank **301** and are positioned and oriented to be incorporated into cushioning element **200**.

The combination of extractor **320** and pad components **230** is then positioned adjacent to heating plate **330**, as depicted in FIGS. **11**G and **12**G. Additionally, first material layer **210** is placed between pad components **230** and heating plate **330**. Extractor **320** and heating plate **330** then close upon and compress first material layer **210** and pad components **230**, as depicted in FIGS. **11**H and **12**H. As discussed above, base **331** of heating plate **330** incorporates heating elements. As such, the temperature of base **331** may be elevated to a point where bonding occurs between first material layer **210** and pad components **230**. Although extractor elements **322** are depicted as protruding into heating plate **330**, extractor elements **322** may have a retractable configuration that retracts into base **321**.

When compressed between extractor **320** and heating plate **330**, energy from heating plate **330** may be utilized to bond first material layer **210** and pad components **230** to each other. As discussed above, a thermoplastic polymer material melts when heated and returns to a solid state when cooled sufficiently. Based upon this property of thermoplastic polymer materials, thermalbonding processes may be utilized to form a thermalbond that joins first material layer **210** are pad components **230**. In this context, thermalbonding may involve, for example, (a) the melting or softening of thermoplastic materials within either of first material layer **210** and pad components **230** that joins the elements together, (b) the melting or softening of a thermoplastic material within pad components **230** such that the thermoplastic polymer material extends into or infiltrates the structure of a textile utilized for first material layer **210**, or (c) the melting or softening of a thermoplastic material within first material layer **210** such that the thermoplastic polymer material extends into or infiltrates the structure of pad components **230**. Thermalbonding may occur when only one element includes a thermoplastic polymer material or when both elements include thermoplastic polymer materials. Additionally, thermalbonding does not generally involve the use of stitching or adhesives, but involves directly bonding elements to each other with heat. In some situations, however, stitching or adhesives may be utilized to supplement the thermalbond or the joining of elements through thermalbonding. As an alternative to thermalbonding, an adhesive, a thermally-activated adhesive, or other securing structure may be utilized to join first material layer **210** and pad components **230**.

As discussed above, a surface of base **331** that contacts portions of cushioning element **200** during the manufacturing process may incorporate a rubber or silicone material. Referring to FIG. **12**H, extractor elements **322** are spaced from and do not contact base **331**. In situations where the compression of first material layer **210** and pad components **230** induces extractor elements **322** to contact base **331**, the rubber or silicone material may be present to receive end areas of extractor elements **322**. That is, the end areas of extractor elements **322** may pierce and enter the rubber or silicone material during the compression of first material layer **210** and pad components **230**.

Following compression and bonding, extractor **320** and heating plate **330** separate to expose the bonded first material layer **210** and pad components **230**. At this stage, the thermoplastic material, adhesive, or other element that joins first material layer **210** and pad components **230** may have an elevated temperature or may not be fully cured. In order to prevent separation between first material layer **210** and pad components **230**, extractor sheet **324** may be pulled from base **321**, which effectively pushes pad components **230** from extractor elements **322**, as depicted in FIGS. **11**I and **12**I. That is, extractor sheet **324** is separated from extractor elements **322** to push pad components **230** from extractor **320**. Upon fully separating extractor sheet **324** from extractor elements **322**, the combination of first material layer **210** and pad components **230** is free from extractor **320**, as depicted in FIGS. **11**J and **12**J.

Continuing with the manufacturing of cushioning element **200**, the combination of base layer **110** and bonding element **120** is placed adjacent to press plate **340**, second material layer **220** is placed adjacent to heating plate **330**, and the combination of first material layer **210** and pad components **230** is located between these elements, as depicted in FIGS.

11K and 12K. Referring specifically to FIG. 12K, note that (a) pad components **230** are located to correspond with a position of first compressible element **342** and (b) bonding element **120** is located to correspond with a location of second compressible element **343**. Press plate **340** and heating plate **330** then close upon and compress the elements, as depicted in FIGS. 11L and 12L. Given the elevated temperature of base **331**, bonding (e.g., thermalbonding) occurs between (a) first material layer **210** and a portion of bonding element **120** that is adjacent to aperture **111** to secure first material layer **210** to interior surface **106** of base layer **110**, (b) second material layer **220** and a portion of bonding element **120** that is spaced from aperture **111** to secure second material layer **220** to interior surface **106** of base layer **110**, and (c) second material layer **220** and pad components **230**. Note that this process also secures or bonds (a) first material layer **210** to a portion of bonding element **120** that is adjacent to aperture **111** and (b) second material layer **220** to a portion of bonding element **120** that is spaced from aperture **111**.

The varying compressibilities of first compressible element **342** and second compressible element **343** assist with forming the various bonds discussed above. Pad components **230** exhibit greater thickness than other elements within cushioning element **200**. As a result, first compressible element **342** compresses or otherwise deforms to accommodate the thickness of pad components during bonding of second material layer **220** and pad components **230**. Second compressible element **343** has lesser compressibility than first compressible element **342** because the thickness of base layer **110**, bonding element **120**, and material layers **210** and **220** is relatively small. Although second compressible element **342** will compress during the formation of bonds between (a) first material layer **210** and a portion of bonding element **120** that is adjacent to aperture **111** and (b) second material layer **220** and a portion of bonding element **120** that is spaced from aperture **111**, the degree of compression will be less than that of first compressible element **342**. Accordingly, compressible elements **342** and **343** each have compressibilities that accommodate the thicknesses of the components being compressed.

Although utilizing both compressible elements **342** and **343** provides an effective manner of bonding various elements, other configurations for press plate **340** may also be utilized. For example, second compressible element **343** may be absent in some configurations of press plate **340**. Additionally, press plate **340** may be formed to have a contoured configuration with a depression for receiving pad components **230** instead of both of compressible elements **342** and **343**.

Once compression and bonding are complete, heating plate **330** and press plate **340** separate to expose the bonded base layer **110**, bonding element **120**, first material layer **210**, second material layer **220**, and pad components **230**, as depicted in FIGS. 11M and 12M. At this stage of the manufacturing process, the manufacture of a portion of apparel **100** and cushioning element **200** is effectively complete.

The above discussion of FIGS. 11A-11M and 12A-12M provides an example of a suitable manufacturing process for a portion of apparel **100** and cushioning element **200**. In general, an advantage of the manufacturing process is that the arrangement of die elements **312** determines the resulting arrangement of pad components **230** in cushioning element **200**. That is, die **310** is initially set such that die elements **312** are positioned in a particular arrangement, and the resulting positions of pad components **230** effectively mirrors the arrangement of die elements **312**. Accordingly, the positions of pad components **320** may be pre-selected through the arrangement of die elements **312**.

An additional advantage of the manufacturing process is that all the elements of cushioning element **200** may be joined through thermalbonding without the need for additional manufacturing steps. In some configurations, however, optional stitching, adhesive, or thermalbonding steps may be utilized to supplement the joining of material layers **210** and **220** around the periphery of pad components **230**. As an example, referring to FIGS. 11N and 12N, a sewing or stitching machine **370** may be utilized to further secure material layers **210** and **220** to each other. Additionally, sewing or stitching machine **370** may be utilized to incorporate cushioning element **200** into apparel **100** or another article.

A variety of other manufacturing processes or variations of the manufacturing process discussed above may also be utilized. For example, extractor elements **322** may retract within base **321**. Although extractor elements **322** are depicted as having a length that is less than a thickness of pad components **230**, extractor elements **322** may have a greater length. An advantage of forming extractor elements **322** to have a greater length is that pad components **230** with greater thicknesses may be formed and incorporated into cushioning component **200**. In other configurations, ejection material **313** may be absent or a mechanized ejector may be utilized within die elements **312**. Moreover, extractor elements **322** may be removable or positioned in various locations to allow different configurations of pad components **230**. Moreover, specialized machinery may be formed to automate the general manufacturing process discussed above.

As a further matter, extractor **320** and press plate **340** are depicted as being located below heating plate **330** in various steps. An advantage to this configuration relates to the positioning of elements forming cushioning element **200**. More particularly, when extractor **320** and press plate **340** are below heating plate **330**, the elements forming cushioning element **200** may be arranged or otherwise positioned on extractor **320** and press plate **340** prior to the application of heat from heating plate **330**. In this configuration, heat is applied to the elements of cushioning element **200** only when heating plate **330** compresses the elements against either extractor **320** or press plate **340**. Accordingly, the elements forming cushioning element **200** may be arranged in the absence of applied heat in configurations where heating plate **330** is above extractor **320** and press plate **340**.

Further Cushioning Element Configurations

Aspects of cushioning element **200** may vary, depending upon the intended use for cushioning element **200** and the product in which cushioning element **200** is incorporated. Moreover, changes to the dimensions, shapes, and materials utilized within cushioning element **200** may vary the overall properties of cushioning element **200**. That is, by changing the dimensions, shapes, and materials utilized within cushioning element **200**, the compressibility, impact force attenuation, breathability, flexibility, and overall mass of cushioning element **200** may be tailored to specific purposes or products. A plurality of variations for cushioning element **200** are discussed below. Any of these variations, as well as combinations of these variations, may be utilized to tailor the properties of cushioning element **200** to an intended use or particular product. Moreover, any of these variations may be manufactured through the process or variations of the process discussed above.

A further configuration of cushioning element **200** is depicted in FIG. **13**, wherein a frame component **240** is positioned to extend around and between various pad components **230**. Although pad components **230** are secured to material

layers **210** and **220**, frame component **240** may be unsecured to layers **210** and **220**, and a thickness of frame component **240** may be less than the thickness of pad components **230**. An advantage of frame component **240** relates to providing additional protection when objects contact cushioning element **200** and protrude between pad components **230**.

As discussed above, pad components **230** have an elliptical or generally elongate shape with rounded end areas. Pad components **230** may, however, have a variety of other shapes, including round, triangular, and hexagonal, as respectively depicted in FIGS. **14**A-**14**C. Pad components **230** may have an irregular shape, as depicted in FIG. **14**D, or may be a mixture of different shapes, as depicted in FIG. **14**E. Although each of pad components **230** may have the same shape and size, pad components **230** may also have generally similar shapes with a variety of different sizes, as depicted in FIG. **14**F.

In addition to aspects of pad components **230** that may vary significantly, the overall shape of cushioning element **200** may vary. Referring to FIG. **14**G, cushioning element **200** exhibits a generally round or circular shape. In further configurations, cushioning element **200** may have a triangular, hexagonal, or H-shaped structure, as respectively depicted in FIGS. **14**H-**14**J. Various shapes for cushioning element **200** are also depicted in association with apparel **100** in FIGS. **1-5**. An example of one of cushioning elements **200** that has a shape suitable for a hip pad is depicted in FIG. **14**K. As more examples, one of cushioning elements **200** from apparel **100** that has a shape suitable for a thigh pad is depicted in FIG. **14**L, and one of cushioning elements **200** from apparel **100** that has a shape suitable for a tailbone pad is depicted in FIG. **14**M.

Various aspects relating to first material layer **210** and second material layer **220** may also vary significantly. As discussed above, material layers **210** and **220** may be formed from various textiles, polymer sheets, leather, synthetic leather, or combinations of materials, for example. Referring to FIG. **14**N, first material layer **210** is depicted as having the configuration of a mesh material that defines a plurality of holes, through which pad components **230**. In addition to imparting greater breathability that allows the transfer of air and moisture, a mesh material may allow for various aesthetic properties. More particularly, pad components **230** may have different colors that are visible through first material layer **210**. In addition to a mesh material, other at least semi-transparent textile or polymer sheet materials may also permit pad components **230** with different colors to be visible. In further configurations, first material layer **210** may be entirely absent from cushioning element **200**.

Although the thicknesses of pad components **230** (i.e., distance between surfaces bonded to material layers **210** and **220**) may be constant, pad components **230** may also have varying thicknesses, as depicted in FIG. **15**A. In some configurations of cushioning element **200**, pad components **230** located in the central area may have lesser thickness than pad components **230** located in the peripheral area, as depicted in FIG. **15**B. The thicknesses of pad components **230** may also decrease across the width of cushioning element **200**, as depicted in FIG. **15**C, or may taper across the width of cushioning element **200**, as depicted in FIG. **15**D.

Further Apparel Configurations

Apparel **100** is depicted in FIGS. **1-5** as having the general configuration of a shorts-type garment. Referring to FIG. **16**A, leg regions **102** of apparel **100** extend downward to a greater degree, thereby imparting the configuration of a pants-type garment that includes additional cushioning elements **200** for the knees of individual **10**. A similar configuration is depicted in FIG. **16**B, wherein apparel **100** includes additional cushioning elements **200** for the ankles or lower legs of individual **10**.

In addition to shorts-type garments and pants-type garments, a variety of other types of apparel may also incorporate cushioning elements **200** in any of the configurations discussed above. Referring to FIG. **16**C, an article of apparel **400** having the configuration of a shirt-type garment is depicted as including two cushioning elements **200** in locations that correspond with elbows of a wearer. When worn, cushioning elements **200** may provide protection to the elbows. That is, cushioning elements **200** may attenuate impact forces upon the elbows. In addition to attenuating impact forces, cushioning elements **200** may also simultaneously provide one or more of breathability, flexibility, a relatively low overall mass, and launderability. Although apparel **400** is depicted as a long-sleeved shirt, apparel **400** may have the configuration of other shirt-type garments, including short-sleeved shirts, tank tops, undershirts, jackets, and coats, for example. Referring to FIG. **16**D, apparel **400** is depicted as including six cushioning elements **200** in locations that correspond with elbows, shoulders, and sides of a wearer.

Cushioning elements **200** may also be incorporated into apparel that covers other areas of the wearer, such as hats, helmets, wraps, footwear, socks, and gloves, for example. As an example, a wrap **500** with one cushioning element **200** is depicted in FIG. **16**E. Wrap **500** has a generally cylindrical configuration that may be placed upon an arm or a leg of a wearer. When, for example, the elbow is sore or injured, cushioning element **200** of wrap **500** may be located over the elbow to assist with protecting the elbow during athletic activities. As another example, a sockliner **600** that incorporates a cushioning element **200** is depicted in FIG. **16**F. Sockliner **600** may be located within an article of footwear to cushion a lower (i.e., plantar) surface of the foot. Additionally, one or more cushioning elements **200** may be incorporated into a glove **700**, as depicted in FIG. **16**G, to impart protection to a hand of the wearer. One or more cushioning elements **200** may also be incorporated into a helmet **800**, as depicted in FIG. **16**H, to impart protection to a head of the wearer. In addition to attenuating impact forces, cushioning elements **200** in these configurations may also simultaneously provide one or more of breathability, flexibility, a relatively low overall mass, and launderability.

The invention is disclosed above and in the accompanying figures with reference to a variety of configurations. The purpose served by the disclosure, however, is to provide an example of the various features and concepts related to the invention, not to limit the scope of the invention. One skilled in the relevant art will recognize that numerous variations and modifications may be made to the configurations described above without departing from the scope of the present invention, as defined by the appended claims.

The invention claimed is:

1. A method of manufacturing an article of apparel, the method comprising:

bonding a thermoplastic polymer element to a base layer;

forming an aperture through the thermoplastic polymer element and the base layer;

securing at least one foam component between a first material layer and a second material layer; and

bonding the first material layer and the second material layer to the thermoplastic polymer element by securing the first material layer to the thermoplastic polymer element adjacent to the aperture and by securing the second material layer to the thermoplastic polymer element at a location that is spaced from the aperture.

2. The method recited in claim 1, wherein the step of forming the aperture includes positioning the aperture in a central area of the thermoplastic polymer element.

3. The method recited in claim 1, wherein the step of forming the aperture includes extending the thermoplastic polymer element entirely around the aperture.

4. The method recited in claim 1, wherein the step of securing includes applying heat to bond the foam components to the first material layer and the second material layer.

5. The method recited in claim 1, further including a step of locating the base layer and the first material layer to form a portion of an exterior surface of the apparel.

6. The method recited in claim 1, wherein the step of bonding the first material layer and the second material layer to the thermoplastic polymer element includes positioning the foam components to correspond with a location of the aperture.

7. The method recited in claim 1, further including a step of forming stitches through the base layer, the thermoplastic polymer element, the first material layer, and the second material layer.

8. A method of manufacturing an article of apparel, the method comprising:

bonding a thermoplastic polymer element to a base layer, the base layer having a first surface and an opposite second surface, wherein the thermoplastic polymer element is bonded to the second surface of the base layer;

forming an aperture through the thermoplastic polymer element and the base layer;

forming a cushioning element by securing a plurality of foam components between a first material layer and a second material layer, wherein the second material layer is larger than the first material layer so that a portion of the second material layer extends beyond an outermost edge of the first material layer;

positioning the cushioning element proximate the aperture so that the first material layer is in direct contact with the thermoplastic polymer element and indirect contact with the second surface of the base layer and the second material layer is in direct contact with the thermoplastic polymer element;

bonding the first material layer and the second material layer to the base layer by melting the thermoplastic polymer element.

9. The method recited in claim 8, wherein the step of positioning the cushioning element proximate the aperture includes aligning the plurality of foam components with the aperture.

10. The method recited in claim 8, wherein the thermoplastic polymer element is bonded to the base layer by melting the thermoplastic polymer element and subsequently cooling the thermoplastic polymer element.

11. The method recited in claim 8, wherein the plurality of foam components are made of a thermoplastic polymer material.

12. The method recited in claim 11, wherein the plurality of foam components are secured to the first material element and the second material element by applying heat to the first material element, the second material element, and the plurality of foam components.

13. The method recited in claim 12, wherein the plurality of foam components are secured to the first material element and the second material element by applying pressure to the first material element, the second material element, and the plurality of foam components.

14. The method recited in claim 8, wherein the aperture is formed with a cutting tool.

15. The method recited in claim 14, wherein the cutting tool includes a laser.

16. The method recited in claim 8, further comprising the step of stitching the second material element to the base element.

17. The method recited in claim 8, further comprising the step of stitching the first material element and the second material element to the base element.

18. The method recited in claim 8, wherein the first material element is positioned adjacent an edge of the aperture so that the first material element separates the second material element from direct contact with the edge of the aperture.

19. The method recited in claim 8, wherein the step of bonding the first material layer and the second material layer to the base layer is performed by pressing the first material layer, the second material layer, the base layer, and the base layer between a press plate and a heated plate.

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